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TABLE OF CONTENTS.

Page.

LEADING ARTICLES:
The Fruhling System of Suction Dredging (illustrated); John Reid, M. Inst. Naval Architects 237
An All Steel Mine Car 239
Notes on Canadian Retort Coke and Its Manufacture (illustrated); Randolph Bolling, M. Am. Chem. Soc 240
A Proposed Rectangular Elevated Water Tank for the Water Supply of Calcutta 243
Hardening Heavy Armor-Plates for a Bank Vault (illustrated) 244
Cost Reduction for Manufacturing Plants; Maurice Gesundheit 244
Preliminary Report of the Inland Waterways Commission 247
The Development of the Mechanical Filter Plant 249
A Hoist for Feeding Material to the Concrete Mixer (illustrated) 251
A Study of the Economic Cost of Typhoid Fever in Wards 8 and 11, Pittsburg, Pa. 252
Costs on a Reinforced-Concrete Factory Building 252
Types of Rapid-Transit Cars for Maximum Service (illustrated) 262
Adjustable and Portable Forms for Concrete Building Construction (illustrated) 264
A Diagram of High Finance 264

EDITORIAL 253
A Typhoid Fever Survey at Pittsburg, Pa.—Estimates for an Inland Waterway Parallel with the Atlantic Coast—Salaries in the Patent Office—The Report of the Quebec Bridge Commission.
The Inland Waterways Commission's Report 253
The New York Barge Canal vs. the Deep Waterway 254

Page.

LETTERS TO THE EDITOR 256
Advertising Defacements in Public Places; E. Raffin—A Sewage Sprinkler Nozzle Used on Experimental Percolating Filters at Worcester, Mass. (illustrated); M. Gault—The First International Highway Congress; Paris, 1908; Dr. Guglielminetti—A Wooden Floor for a Street Foundation; J. G. Hult—Applying the Engineering News Formula for the Bearing Power of Piles; "X. Y. Z."—The Pekin-to-Kalgan Railway, China (illustrated); R. W. Toll—The Portland & Seattle R. R.; W. P. Hardesty; T. H. Curtis—"The Cheapest Railway in the World"; J. L. Campbell—A Railway Location Problem; To Connect a Crossing of a Straight and Curved Track by a Curve When Both Frog Angles and the Position of Frog in Straight Track are Fixed (illustrated); C. C. Washington—Pearson's Work on the Hudson Tunnel; A Correction; W. I. Ames—The Inventor of the Automatic Car System; J. L. Harrington; C. T. Steffins—Heat Expansion Stresses in Chimneys; F. H. Hummel—The New British Patent Law and Its Relation to Foreign Patents; J. P. O'Donnell, M. Am. Soc. C. E.—The Effect of Alum and Clay in the Waterproofing of Concrete; S. A. Brown—The Heaving of Bridge Abutments by Frost on the Ground; E. H. Rigby—The Permanency of Yield of Driven Wells; G. Bowers—Work on the Southwest Pass Channel at the Mouth of the Mississippi; E. H. Ruffner—A Severe Examination for Civil Engineers—Notes and Queries.
ENGINEERING NEWS OF THE WEEK 265
PERSONALS 266
ENGINEERING SOCIETIES 266

THE FRUHLING SYSTEM OF SUCTION DREDGING.

By JOHN REID,* M. Inst. Naval Architects, M. Inst. Engineers and Shipbuilders in Scotland.

The success of the hydraulic or suction system of dredging in the last quarter of a century has been very great. Without the aid of dredges of this type it would scarcely have been possible for the engineers engaged in river and harbor improvement to keep pace with increasing size and draft of modern steamships.

Yet, paradoxical as it may appear, the hydraulic dredge is one of the most wasteful and inefficient mechanical appliances in existence. With every cubic yard of material raised by the pump, a great quantity of superfluous water has also to be elevated only to be discharged again. In some of the largest and most up-to-date dredges of the hopper type it has been found that oftentimes in practical work—with some material, such as coarse sand—not one-tenth of the energy expended at the pump is usefully employed in elevating solid material which can be secured in the hopper and for which payment can be claimed. In softer materials, such as fine sand and mud, the loss of efficiency may be even greater.

It cannot be said that this low efficiency in hydraulic dredges has been ignored by dredge designers and operators, but after innumerable experiments the consensus of opinion came to be that it was inherent in the nature of the appliance and that for every cubic yard of sand or mud three cubic yards or more of water must be passed through the pump and flung out again.

It may be well to consider briefly the usual method of operation of the ordinary suction dredge, in order to illustrate some of the causes for its low efficiency. Such a vessel dredging in a harbor or river channel trails behind it one or more flexible suction pipes connecting with the suction pumps through elbow bends passing through glands on the vessel's sides. The bottom ends of the suction pipes may be left entirely open or partially restricted, as is common practice, by scraper heads of various forms. These serve to break up the surface as well as to prevent the pipes from becoming choked by large bodies. The suction action of the centrifugal pumps is communicated to the pipe ends and an immediate inrush of water takes place from all around and to some extent also through and from under the material to be dredged. Some of this material is sucked in by the inrush of water and the mixture passes through the pumps into the hopper, where the sand precipitates to the bottom and the superfluous water passes overboard through the overflow ducts. In some cases mechanical means, such as toothed wheel cutters, are fitted to the open ends of the suction pipe in order to assist in cutting up the surface and increasing the disturbance of the bottom and therefore the proportion of solids pumped.

It would seem, however, that in such a method of operation the one essential feature is that there should be a copious inrush of water. This is ordinarily beyond the control of the dredge operators, and in passing over a hard spot, where the sand has packed, the amount of material raised is often absolutely nil, while again in a soft spot the proportion of sand may be fairly high, and in mud the rush of material from the discharge pipe would be very satisfactory were it not that the greater proportion of it cannot precipitate in the hopper before it is lost overboard through the overflow pipes.

It is easy to infer that in any attempt to improve the efficiency of the suction dredge an effort must be made not merely to loosen but also to secure the material by a mechanical cutting of the surface, and also to control the inrush of water at the suction pipe entrance. To achieve either of these results is to greatly improve the suction dredge. Otto Fruhling, of Braunschweig, Germany, a contractor, dredge operator and designer, has developed a new system of suction dredging which fulfills the above desiderata and possesses other features of great value.

In watching an ordinary suction dredge, at work on the Kiel Canal, it occurred to Fruhling that by fitting a large inverted dipper dredge bucket on the bottom end of the suction pipe he might scrape up and collect the dredged material before the suction forces came into play. Such was the crude idea which by numerous experiments on full sized dredges has resulted in the Fruhling Suction Dredge, whose operations prove it to be the most powerful and economical dredging appliance yet developed.

It was to be expected that the addition of the broad bucket head with its ponderous weight and sharp cutting edge would produce a greatly increased supply of sand and mud to the suction pump, but it was hardly anticipated that the action would be such as to completely bar the admission of the surplus water; yet such was found to be the case, and to such an extent as to require the fitting of pressure water connections to the inside of the bucket head, so that sufficient water might be pumped in at will to liquefy the solid material and bring it to such a consistency

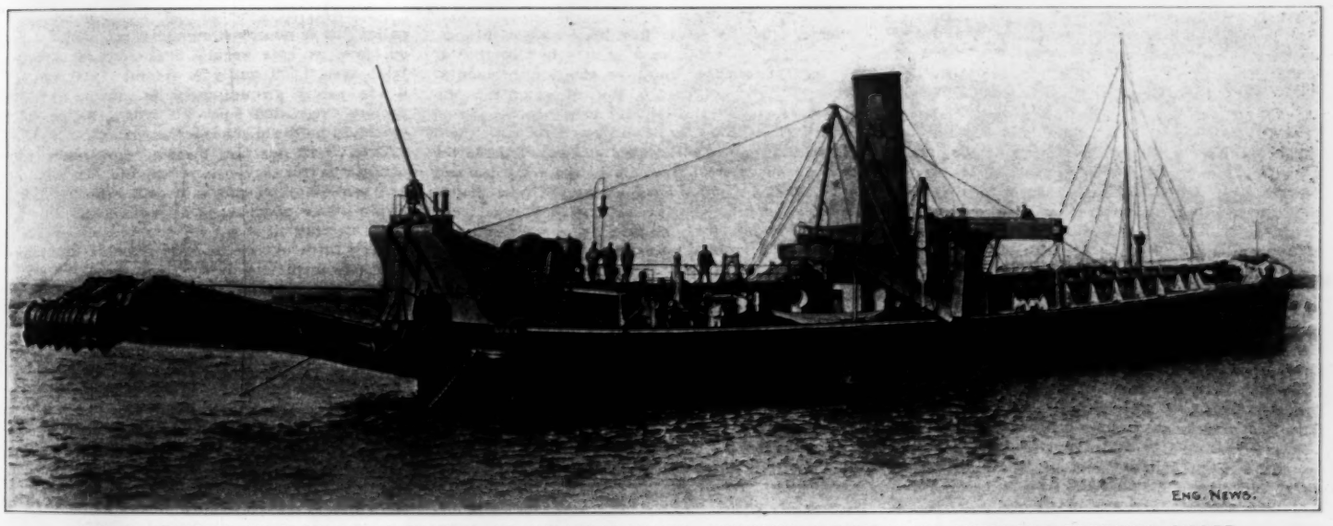

FIG. 1. "DREDGE VII.," FRUHLING SYSTEM, AT WILHELMSHAVEN, GERMANY. FITTED WITH EXTENDED DREDGING GIRDER.

*John Reid and Co., Naval Architects, 41 Park Row, New York City.

as would enable the suction pumps to handle it. Small valves added to the head permitting a certain inflow of the surrounding water at the will of the operator were also fitted.

In the interior of the scraper head before the dredged material comes into range of the suction it is forced into a mixing chamber where the dredgings are reduced to a uniform consistency by the pressure water or by the mere admission of outside water. From the mixing chamber the material is drawn through the pumps and is discharged into the hopper.

The condition of the material as it leaves the discharge pipe is remarkable. It bears no resemblance to the usual hopper discharge, which appears mainly to consist of water with a tinge here and there of mud and sand, but on the contrary is a dense black or gray semi-fluid somewhat similar in consistency to mortar. With suitable material the water contained can be so reduced as to allow the dredgings to retain an impression for an appreciable period of time and even to stand up in a pile as dropped without immediate tendency to flow down. In soft, muddy and earthy material it was found possible to pump and secure 90% *of solid material* where, with ordinary dredges, 15% to 20% had been considered highly satisfactory. While it had been hoped to reduce the surplus water, it was found that, with this material, it had been practically eliminated. In coarse sand, or sand and mud mixed, the results were equally surprising; where the pumping of 10% to 15% of solids had before been considered good work, it was found possible under the new system to pump 50, 60 and even 70% of solid dredgings. These results were simply revolutionary, and certainly inaugurated a new era in suction dredging.

The German Government was quick to recognize the remarkable claims of the new system. During the last five years more than a dozen large suction dredges of the Fruhling type have been constructed for service at the principal Baltic and North Sea ports and canals, and several have been delivered in other countries.

The largest one yet built is "Dredge VII.," belonging to the German Government and employed in widening and maintaining the approach channels through the Jade Estuary to the great North Sea naval station of Wilhelmshaven. This vessel (Fig. 1), probably the most powerful dredge afloat, will serve to illustrate the construction and operation of the Fruhling dredge. The principal dimensions of Dredge VII. are: length, 265 ft.; breadth, 48 ft.; depth, 20 ft. There is one large hopper forward of the machinery space with a total capacity of 2,000 cu. yds., provided with bottom doors for discharging the dredgings by dumping. The propelling and pumping machinery consists of four sets of triple-expansion engines each unit of 500 I.HP. These four units are arranged tandem, two on each bed plate, and drive twin screws. The two aftermost engines are coupled direct to the propeller shafts and the two forward units to the suction pumps. When it is desired to exert full power (2,000 I.HP.) on the propellers, as when steaming at sea or to a dump with a load, a clutch mechanism connects the forward and after units on each bed plate. In dredging, only the after pair of engines are used for propulsion while a speed usually of from four to five knots over the ground is maintained, and the forward pair of engines drive the pumps. All four engines exhaust to a central condensing installation with separate air, feed and circulating pumps. The arrangement lends itself to great economy, the coal consumption working out at the surprising figure of 0.85 lbs. per I.HP.-hr. over long periods of work.

The suction pumps are two in number, each with a diameter of 5 ft. 2 ins. When working in mud the speed of the pump is about 200 r. p. m., and when working in sand is 140, both figures of course being variable. The design of the pump is a very important element in the success of the Fruhling dredge, and it may be said briefly that the characteristic features are small diameter, high speed and small clearances.

The most striking features of the Fruhling dredge are the arrangement of the suction arm and the bucket head. In "Dredge No. VII.," and in most other dredges of the type, the hull is cut in two by a narrow fore and aft channel or well, terminating just abaft the after pair of propelling engines. At the forward end of this well at about the level of the water line a massive pillow-block on each side supports a pair of hollow trunnions, by which is supported the heavy bridge-girder frame, which carries the suction and pressure pipe and bears the stresses coming on to the dredging head. At the lower end of the girder is a huge pair of hinges, by which the bucket head is attached so that it has a movement of rotation about a horizontal axis at right angles to the direction of the girder, to enable the cutting angle to be varied at will. The hinges are hollow and through them the suction pipes enter the bucket. This latter is made up of steel castings bolted together and is 16 ft. 6 ins. broad by about 5 ft. in depth. It has a cutting edge studded with hollow teeth through which jets of pressure water can be ejected to help break up tough material. There are also baffle plates to reduce the size of the entrance, and a series of bars to form a grid and prevent the admission of undesirable objects.

The operation of the Fruhling dredge is briefly as follows: The heavy head is dragged over the bottom at a speed of four or five knots. It scrapes or plows off a strip as wide as itself, from 12 to 18 ft., and from 12 to 18 ins. in depth. The material as it is plowed up is forced into the head by the pressure of the scooping action. Here it is kneaded, mixed and liquefied as may be found necessary and finally is sucked up by the pump. The action is quite continuous but is in two distinct stages; first the mechanical cutting and mixing and then the removal by suction, the suction forces acting entirely inside the head and not outside of it as in the ordinary dredge.

In her trials Dredge No. VII. greatly exceeded anticipations. The contract [illegible]

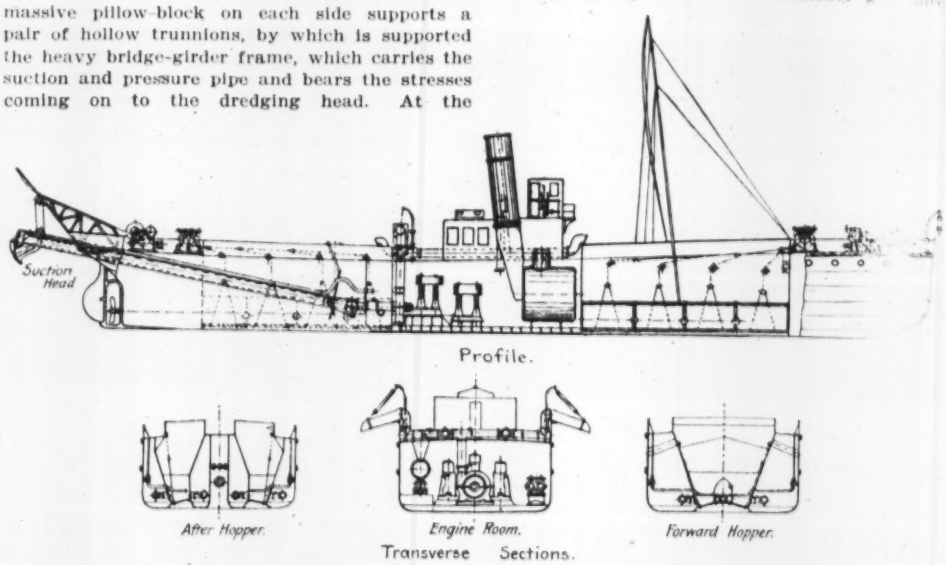

FIG. 2. HOLD PLAN, LONGITUDINAL AND CROSS SECTIONS OF TYPICAL FRUHLING DREDGE.

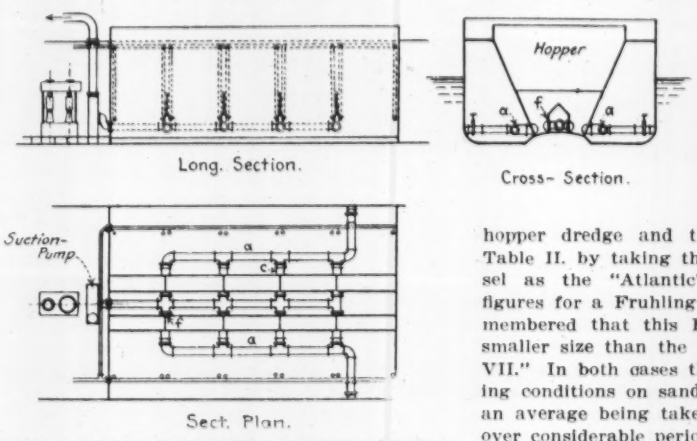

FIG. 3. HOPPER DISCHARGE SYSTEM OF THE FRUHLING DREDGES.

called for a pumping capacity per hour of 1,500 cu. yds. in soft ground. The actual result on trial was 6,500 cu. yds. (about 7,700 tons); in heavy sandy ground (specific gravity, 1.95) the dredge excavated 4,680 cu. yds., the proportion of solids in the discharge being 65%.

This vessel has now been at work under varied conditions for several years and working data are available covering a considerable period. In Table I. a comparison has been instituted between the Fruhling dredge and the vessels of the ordinary form of the nearest possible similar size and power in use in the United States. In all cases the material is approximately the same and the working conditions are similar; vessels dredging free sand and mud in open waters from a depth of 25 to 40 ft. The rates of pumping are taken as an average over several months work, except in the case of the Panama dredges, for which long-term results are not available.

An even more remarkable comparison of the two systems, the open-mouthed, flexible pipe, hopper dredge and the Fruhling, is made in Table II. by taking the capacity of such a vessel as the "Atlantic" and the corresponding figures for a Fruhling dredge. It should be remembered that this Fruhling boat is of much smaller size than the "Atlantic" or the "Dredge VII." In both cases the results are from working conditions on sand bars in open waters and an average being taken of operations extending over considerable periods of time.

It will be noticed that, accompanied with a great reduction in size, power, cost and upkeep expenditure, the pumping capacity of the Fruhling is greatly in excess of that of the vessel of ordinary type. There can be no advantage from mere size and power in a dredge (apart from the ability to go to dump with a big load) when from 70% to 90% of the energy exerted in raising dredgings is wastefully employed in pumping water, or in pumping solids which cannot be retained. It is obvious that the positive

TABLE I.—COMPARISON OF FRUHLING HYDRAULIC DREDGE VII. WITH AMERICAN HYDRAULIC HOPPER DREDGES.

	Fruhling No. VII.	Atlantic and Manhattan.	Delaware.	Ancon and Culebra.	Mills and Thomas.
Length	265' 0"	274' 0"	300' 0"	274' 0"	300' 0"
Breadth	48' 0"	47' 6"	52' 0"	47' 6"	52' 6"
Depth	20' 0"	25' 0"	22' 6"	25' 0"	25' 0"
Draft loaded	16' 0"	18' 0"	18' 3"	18' 0"	23' 0"
Hopper capacity (cubic yards)	2,000	2,300	2,200	2,300	3,000
Number and diameter of suction pumps	2 @ 5' 2"	2 @ 9' 0"	2 @ 8' 2"	2 @ 9' 0"	1 @ 8' 0"
Revolutions per minute	180 to 200	180	180	180	126
Cubic yards pumped per minute	33	10	11	10	12.2
Cubic yards pumped per hour	1,980	600	660	600	732
Hopper contents in average load (cubic yards)	1,900	2,140	2,200	——	2,200
Time to dredge average load (minutes)	57	220*	200	——	180*
Indicated horsepower (on propellers)	2,000	1,800	1,800	1,800	2,000
Speed loaded (knots)	10	10	10	10	8
Cost in United States (each vessel)	$375,000	$350,000	$375,000	$365,000	$490,000

*Average time taken to fill hopper during one year's work.

NOTE.—Material in all cases is fine sand mixed with mud as found in New York and Delaware channels. Results from "Ancon" and "Culebra" would be similar to those for "Atlantic" and "Manhattan."

action of the ponderous bucket-head firmly attached to the vessel by a rigid girder-frame must have a much greater dredging effect than a light suction mouthpiece, whether of the hook-ended or grid-shaped type, attached to a thin wrought-iron pipe with flexible joints, free to lift over or pass around any obstruction which it may encounter. The latter arrangement is known to leave hard surfaces untouched and soft material dredged to depths unnecessary and unintentional.

Table I. deals only with material such as sand with a small proportion of mud mixed with it. In mud alone the superiority of the Fruhling dredge would be much more marked. As already noted, the results attained by "Dredge No. VII." in mud and soft earth is a pumping capacity of 6,500 cu. yds. per hour, or a full hopper (2,000 cu. yds.) in less than 20 minutes. The other vessels named, though pumping a comparatively high percentage of solids when working in mud, lose the material so fast through their overflow pipes that the time required to obtain a hopper load is much prolonged.* In fact it may be stated that such vessels are not at all well fitted to deal with mud.

An extraordinary case in point is that of the huge dredge "Ancon," which has just started work in Limon Bay, at the Atlantic end of the Panama Canal. This vessel has a hopper capacity for a load of 2,200 cu. yds. per trip. So fine, however, is the mud which she has encountered since beginning operations, that it has been necessary to go to the dumping ground with loads which average no more than 700 to 800 cu. yds., or about one-third of the vessel's true working capacity. These figures have been printed in the "Canal Record," an official publication, and should be authentic. The trouble is the usual one, that the mud will not settle. After a certain quantity has been secured any further pumping actually reduces the quantity of material in the bins by stirring it up so that it is lost through the overflow.

A secondary valuable feature of the Fruhling dredge is the method by which the hopper contents can be sucked back through the pumps and discharged on shore through a swiveling deck pipe by means of which a temporary connection to a shore line of pipes can be made. Hitherto hopper dredges have had to dump through the bottom doors. If it is desired to use the dredgings for reclamation either a special dredge with connections to a long shore-pipe line is necessary, or with the hopper dredges it is necessary to dump alongside a stationary dredge and repump, with a consequent loss of time, material and money.

This is obviated in the Fruhling design. In Fig. 3 a suction pipe is shown extending along the center of hopper through the hollow center girder and communicating with the interior of hopper through lateral branches f. f. Opposite to these branches on the hopper sides are similar branches c. c. connecting with fore and aft pipes a. a. having sea inlet connections through the ship's side. When the hopper is charged and it is desired to repump its contents, which may have packed very firmly, the sea inlet valves are opened, admitting water into the wing pipes a. a. On opening the valves in the lateral branches c. c. and f. f. and starting the suction pump, water is drawn across the openings between the branches. This rush of water carries the dredgings lying between the pipe branches and the superincumbent masses of material gradually fall down and are sucked into the pumps. The pump discharges through a rising pipe into the swiveling deck pipe shown in Fig. 1, by means of which temporary connection is made to a shore pipe-line. It has been found that approximately the same time is taken to pump the hopper load ashore as was spent in dredging it. Further, the dredgings as dropped from the shore pipe end are in the semi-fluid form, and there is no rush of excess water as with the ordinary shore pumping methods.

In the practical use of the Fruhling dredge several secondary advantages conduce to greater economy and efficiency. For example, the dredge normally operates at a speed of four to five knots over the ground; it is therefore always under good steerage way, and can avoid passing vessels and maintain a fair course against tide and wind. In addition, the action of the cutting head, free from any suction influences, is to leave the surface dredged level and clear of overdepths and side or undercuts. The ordinary suction dredges frequently leave deep pits and high ridges in the dredged channel, and their operation near dock walls or loaded wharfs often involves a serious risk of undermining such works. Slipping of dock walls from this cause has actually happened.

The design of the Fruhling dredge permits the whole suction girder and head to be easily disconnected and removed from the well while the dredge is afloat. The girder may be conveniently lengthened for special work, as shown in Fig. 1, where "Dredge No. VII." has been fitted to enable it to dredge to a depth of 70 ft. in excavating lock sites.

The cutting angle of the dredging head is also easily altered to any suitable angle for a change in dredging depth or to suit different materials; it is secured at any desired angle by chain screws.

One of the serious difficulties encountered by the engineers in charge of river and harbor improvements is to find means to remove the deposits of mud and river-borne silt which continually tend to shoal the channels. This material is so fine and the deposits are so extended as to render inadequate the attempts of ordinary suction dredges to handle it.

It appears inevitable that any attempt to interfere with the natural beds of rivers and tidal inlets must be followed by a tendency toward readjustment through a large increase of deposits in the dredged localities.

For all such work the Fruhling design seems specially adapted by reason of its great success in handling mud and its unique advantages in discharging the material ashore in the best shape for levee building, land raising and reclamation.

In this connection the writer would indicate an important application of this new system in some parts of the Panama work. This is the enormous amounts of filling required for the Gatun and other dams. This filling may best be furnished by dredgings to be pumped into the site of the dams. By the Fruhling system only, does it appear possible to place this material at reasonable cost and in suitable consistency.

The prediction seems safe that the Fruhling system of suction dredging will revolutionize present practice in submarine excavation in soft or free materials such as sand and mud.

*This trouble is frequently referred to in the reports of the U. S. Corps of Engineers. See articles on dredges "Atlantic" and "Manhattan," Engineering News, Sept. 20, 1906.—Ed.

TABLE II.—COMPARISON OF FRUHLING AND COMMON SUCTION DREDGES.

	Atlantic.	Fruhling.
Length	288 ft., 0 ins.	187 ft., 0 ins.
Breadth	48 " 0 "	34 " 6 "
Depth	23 " 0 "	14 " 9 "
Draft (loaded)	18 " 3 "	13 " 1 "
Hopper capacity	2,300 cu. yds.	785 cu. yds.
Hopper contents per load	2,040 "	700 "
Hopper filled (in minutes)	220	44
Cu. yds. lifted per hour	558	940
Cu. yds. lifted per minute	9.3	15.7
Speed loaded (knots)	10	9.75
Dredging depth	35	35
Cost in the United States	$350,000	$200,000

AN ALL-STEEL MINE CAR.

The mine car illustrated herewith has been recently designed by the Arthur Koppel Co., and 200 cars are being built for the New River Pocahontas Consolidated Coal Co., at the Koppel works, while 200 more have been ordered.

The aim of the designer was to make a very low car with large capacity. The top of the car body is only 30 ins. above the rail and the capacity is given as 57½ cu. ft. The gage of track is 44 ins. The wheels are 16 ins. in diameter.

A special feature of the car is the buffer, which is built of a specially rolled steel channel having a small depth and very wide flanges. At the ends of the car this channel has its flanges bent into a semi-circular shape and projected beyond the car end, so as to give clearance between the corners of the cars on curves. This channel is continuous beneath the car, making a continuous buffing column capable of carrying the shocks met in the service, through the train, without transmitting the strain to the car body.

ALL STEEL MINE CAR WITH CONTINUOUS BUFFER.

(Built by the Arthur Koppel Co., Koppel, Pa.)

The large overhang of the sides, which gives the car its large capacity, has been well braced, and the curved corners facilitate the discharge of the load. The end door is well stiffened to give it the necessary rigidity.

THE LONGEST RAILWAY TANGENT IN THE WORLD is said to be on the line of the Buenos Aires & Pacific Ry., in the Argentine Republic. The length of this is 205½ miles and it is situated on the main line between miles 158 and 363½ from Buenos Aires. The straight stretch of track was formerly broken by reverse curves forming a detour round Lake Soria; the longer portion was then 175 miles long, and was even then the world's record. The lake having, however, practically dried up, the company has eliminated the curves, and the "cut-off" was opened to service on Oct. 15, 1907. We are informed by an official of the railway that when the line was located in the '70's (when the country was in the hands of the Indians) after leaving Junin, which was a military out-post and the last point of contact with the Buenos Aires civilization, a course of about west-northwest was set, and the line run straight across the flat "pampas" until it met another line about 60 miles long, which was pushed out eastward from the western terminus at Villa Mercedes. There were no obstacles of importance to avoid, and hence the phenomenal "bee line" was built.

NOTES ON CANADIAN RETORT COKE AND ITS MANUFACTURE.

By RANDOLPH BOLLING,* M. Am. Chem. Soc.

THE COKE PLANT.

Metallurgical coke produced by Bernard and by Bauer retort-ovens is the fuel used in the blast furnace of the Nova Scotia Steel and Coal Company at the Sydney Mines works. The location of the plant is unique in many respects. The works have the distinction of being the farthest north of any iron and steel plant on the North American continent. The battery of 30 Bauer ovens is as far as the writer can discover the only one built on this side of the world. Situated on the east coast of Cape Breton Island at the north side of Sydney Harbor, these works lie in the midst of the immense Sydney coal field. The coke ovens, in fact, are built on land below which coal is being mined, so that transportation problems which are the bugbear in works situated less favorably to their raw materials are thus happily solved at the Sydney Mines Works. Raw slack from collieries Nos. 1, 3 and 5, nearly all from submarine areas, is assembled at the coal-washing plant. The washed slack is elevated directly into a washed-slack tanks at the Bauer ovens which adjoin the washery building. Slack is also taken in 15-ton hopper-bottom cars to the Bernard plant storage towers, located one mile away, and there elevated to large stack towers.

OVENS.—The coking plant proper consists of 120 Bernard ovens of standard dimensions grouped in three batteries of 40 ovens each, as seen in Fig. 1. They are designed to produce coke and fuel gas only and are, therefore, arranged with vertical flues and have no by-product features. The Bauer ovens, however, are arranged with both vertical and horizontal flues for use in case the recovery of by-products should be undertaken. Draft is maintained by fan as an auxiliary to the stack. The coke is discharged by a steam pusher and the slack is charged loose, each oven taking a charge of eight tons of slack and is pushed every 40 to 46 hours. In the Bernard plant the pushing is done by electrically operated machinery designed by Mr. J. H. Darby, M. Iron and Steel Inst., of Brymbo, Wales. Each oven takes a charge of six tons of slack and is pushed every 40 or 48 hours. The flues of battery No. 3 discharge the gases through a short square stack into the atmosphere, whereas batteries Nos. 1 and 2 have flues carrying the gases to a boiler plant and thence out through a 150-ft. stack to the atmosphere. The coke is pushed out on a platform, watered and cooled, and then forked

Fig. 3. Charging the Bernard Coke Ovens with Washed Slack.

into cars. The losses from breeze amount to 3.4% on an average.

In the Bernard retort system the ovens are arranged in couples. Each oven of a couple takes a charge of six tons of slack and they are alternately charged so that the charge in one half is from 20 to 24 hrs. advanced over that in the other.

In this system coke and gas are produced, and as there is no attempt to recover any by-products the flue construction necessarily differs from that of ovens in which it is intended to recover by-products. By allowing partial combustion of the volatile constituents of the coal in the vertical flues which form the division walls between the ovens and by completing the combustion of these volatile products in the main flues, a very high oven temperature is maintained, so that the dimensions of these ovens can be greatly increased over the most common types of by-product ovens that must be very narrow in order to make effective the feeble heating of the burners. The Bernard oven is

FIG. 1. VIEW OF THREE BATTERIES OF BERNARD COKE OVENS. SYDNEY MINES WORKS OF THE NOVA SCOTIA STEEL AND COAL CO.

22 7-16 ins. wide on the pusher side expanding to 24 3-16 ins. at the quenching platform. The object of this is to facilitate the discharge of coke. The dimensions, shown in Fig. 2, indicate that the Bernard oven is extremely wide for the retort type. All materials used in the construction of the ovens were imported from Antwerp, Belgium. All brick were numbered, so that the construction was much simplified for the brick-masons. No chipping or grinding was necessary, each brick fitting into a definite place. Special coke-oven fire bricks were made in forty or fifty different special shapes. These fire bricks appear to be made by mixing small pieces of crushed quartz with the fire clay. Certainly a remarkable coke-oven brick results, one which does not expand like the silica brick commonly employed for this work, and one which withstands high temperature and sudden cooling. In Fig. 2 a typical group of Bernard ovens is shown with two end oven couples. In the Nova Scotia plant, instead of having a single intermediate couple there would be eighteen, as each group is made up of forty ovens.

The coking process is easily outlined by referring to Fig. 2. Suppose that ovens 1, 3 and 5 have just been discharged and recharged through the ports J. Under these conditions ovens 2, 4 and 6 will have been coking for 24 hrs. The temperature of the odd numbered ovens is considerably lowered by introducing the wet slack, but rapidly rises by the combustion of the gases from the even numbered ovens which are still giving off volatile combustible.

Owing to the coupled arrangement the gases from the even numbered ovens give off sufficient heat, before their charges are fully coked, to start coking in the odd numbered ovens just charged. As the coking of these green charges proceeds, rich gases are driven off, the combustion of which heats the walls sufficiently to expel the last of the volatile matter in the maturing charges in the even numbered ovens. The ovens send their gases up through the ports "B," into small combustion chambers "F," where they then mix with hot air drawn down through the ports "H." The combustion proceeds as the gases descend through the vertical walls "D" to the flue "C." The gases from both ovens of a couple finally mix in this flue and pass from "C" (see sectional plan M-N, Fig. 2), under the oven pavements to "A," heating the oven bottom meantime. At "A" the gases pass through an arch in the wall between the coupled ovens and thence back to "B," where they pass down through the damper flue to the main trunk flue. The external walls of the end ovens have the additional flue shown in the longitudinal section T-U to properly heat the end wall. There is a damper at "G" to control the heat in this wall.

In the longitudinal section V-W are shown the concrete arches on which the ovens rest and also the hot air flues under the pavement flues of the ovens. These air flues are necessary to keep up a circulation of air and to prevent too great a concentration of heat in the pavement flues. By manipulation of dampers a circulation is kept up from end to end of each oven at the bottom.

The main trunk flue tapers from 4 ft. 8 in. diameter at oven No. 1, to 6 ft. 10 in. at oven No. 40. By looking through a peep-hole just back of oven No. 1 the discharge of gases from each oven can be observed. The flue is seen filled with tongues of whirling flame which enter from each flue port. The combustion in the main trunk flue heats the walls to incandescence. Under heavy draft pressure from the main stack the heated gases rapidly pass to the boiler plant, about a hundred feet away. After dividing through nine 110-HP. boilers the temperature of the gases is from 300° to 600° F. Under certain conditions such as heavy charging, the supply of oxygen entering the flues is not sufficient for complete combustion of all gases, and intense combustion takes place in the combustion chamber of the boilers. The energy from these boilers is converted to electric current supplied to the coal-washer, open-hearth steel plant, blast furnace, collieries, etc. In a poor market for tar and ammonia this system should be more economical in the end than a recovery type oven, taking first cost into consideration.

Fig. 4. 40-HP. Electric Pusher, for Clearing the Bernard Retort Ovens of Coke. Designed by J. H. Darby, Brymbo, Wales.

The writer believes that this system can be installed for half the cost of the expensive by-product systems. In a self-contained works, as at Sydney Mines, where the ore is reduced to pig and this in turn is refined to steel, where large underground haulage systems and collieries can be run economically by the electric power

*Superintendent of Coke Ovens and Coal Washery and Chief Chemist, Nova Scotia Steel and Coal Co., Sydney Mines, N. S.

developed, burning the by-products should result in greater economy than recovering them.

OPERATION OF OVENS.—The plant is operated on one shift, working 10 hrs. The pushing is timed, as closely as possible, for a coking period of about 48 hrs., but as 60 ovens are cleared each morning, certain conditions, such as the direction of the wind or slowness of certain ovens, may cause shorter or longer periods. When the shift assembles in the morning the foreman selects the battery which from inspection through the peep holes indicates that all volatile matter has been driven out and the ovens show a clear view from end to end, if it is the day to push the odd numbered ovens, 1, 3, 5, 7, etc., the door-hoister hooks a chain to the lifting mechanism and to an eye-bolt in the top of the door frame, opens valve to hydraulic cylinder and hauls the door up on the side next the pusher, repeating the operation on the coke platform side. Both doors now being raised, the pusher is run down the track to a point opposite the oven and the ram started forward; after the shield enters the ovens full power is thrown on the ram motor and the oven pushed in 30 seconds. The wall of red hot coke emerging on the coke platform is allowed to advance half across the platform, when it is thrown down by long grappling hooks. In the meantime a steady stream of water from a 2-in. hose has been directed at the coke from the instant it emerges from the oven until it is all discharged and very rapidly quenches and cools it.

The appearance of the coke, as it issues forth from the oven, is quite striking, looking not unlike a red hot wall with a joint running down the center, and as it topples over, it falls in two distinct lines composed of regular masses of coke about the size and shape of large Belgian blocks used for paving streets. These masses of coke on close examination are wedge shaped and of a beautiful silvery color resembling the color and luster of Connellsville beehive-oven coke. The highest quality, with no black ends or butts, is produced when the ovens are working at their maximum temperature. After an oven is pushed the doors are immediately lowered and five slack larries, holding a total of 6 tons, are discharged through three charging holes on the top. This charging operation is shown in Fig. 3. The electric pusher for the Bernard ovens is shown in Fig. 4. The coke, as quenched and ready for forking into electric cars to be transported to the blast furnaces, is seen in Fig. 5.

The charge is next levelled from both the pusher and the coke sides, by manipulating long scrapers back and forth in the oven through special levelling ports in the top of the doors. After this operation is finished the pusher is moved to the next oven in the line to be pushed, and doors of the oven just charged are carefully plastered at the points of contact with the oven, with a mixture of 70% clay and 30% washery slate. The appearance of the sealed oven doors is shown by Fig. 6.

The plant has been in operation continuously since 1904 and the coke ovens have given good satisfaction, the Bernard ovens making about 80,000 tons per annum and the Bauer about 28,000 tons. This output could have been increased if it had been necessary, but as the coke plant capacity was in excess of the blast-furnace requirements the ovens were not worked to their maximum capacity.

A few words at this point regarding plastering oven doors may be interesting. In order to operate this system of retort ovens, without any damage to the oven pavements by coke ash fusing on the fire-bricks and causing holes to burn through to the flue beneath, the access of air must be prevented. A plastering mixture which the writer has found excellent is prepared by combining ordinary clay, free from gravel and

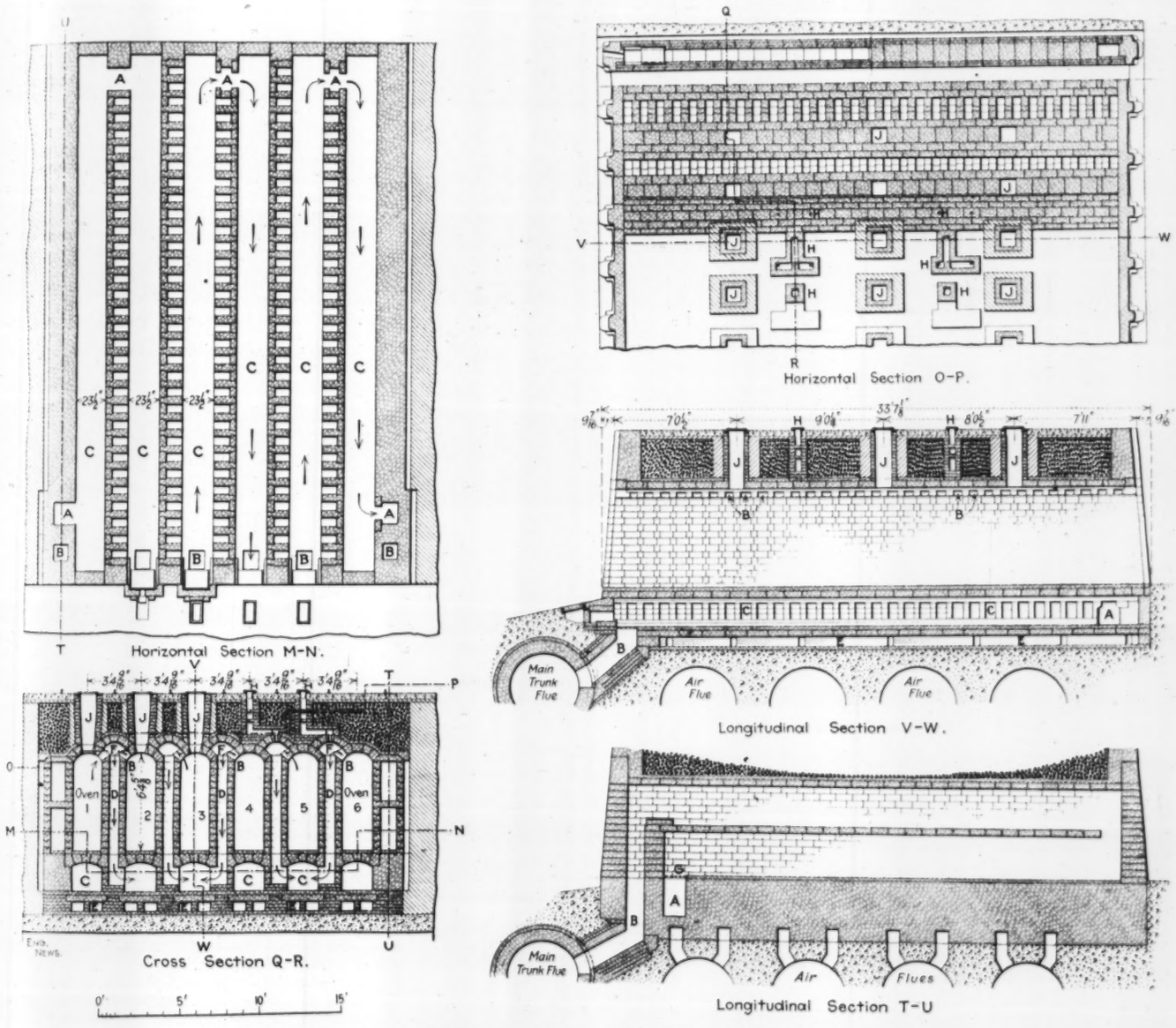

FIG. 2. DIAGRAMMATIC ARRANGEMENT OF WALLS AND FLUES OF BERNARD RETORT OVEN.

sand, with washery slate which is the refuse produced in preparing washed slack coal. It has the following composition (dried at 212° F.):

Moisture (H_2O)	6.48%
Iron Sulphide (FeS)	13.64%
Silica (SiO_2)	28.50%
Alumina (Al_2O_3)	17.59%
Lime (CaO)	6.74%
Magnesia (MgO)	.44%
Manganese Carbonate ($MnCO_3$)	1.56%
Water of Hydration (H_2O)	15.10%
Organic Matter (C)	9.95%
	100.00%

The slate comes in rough chunks of such sizes as would pass through a 1-in. screen and over a ⅛-in. The clay and slate are mixed with hot water in a wood tank and then live steam is injected into the mass for 12 hrs. During this treatment the slate is digested and incorporated with the clay making a plastering mixture that is very adhesive as well as plastic, and which shows a very low shrinkage on drying so that after the doors are plastered and then brushed over with a thin mud they are practically air tight and do not crack or scale off. The adjustment of main flue dampers at the Bernard plant is shown in the accompanying Table I. for each battery, taking No. 3 (ovens Nos. 81 to 120), as an example:

It will be noted that the damper settings alternate between 5.25 and 6.5 ins. up to over 100 and then from 4.5 to 5.75 ins. on to 120. The reason for the difference between 5.25 and 6.5 ins. or between 4.5 and 5.75 ins. has already been noted in discussing the use of ovens in

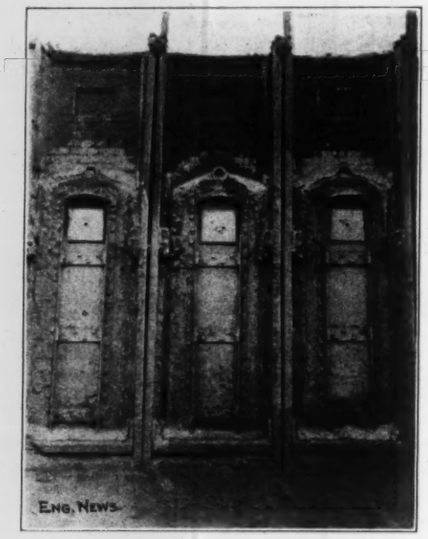

Fig. 6. Doors of Bernard Coke Ovens After Sealing with Slate-Clay Mixture.

couples. In explanation of the breaks in damper settings at ovens 81 and 120 it should be noted that these are the end ovens of the battery and as such have a flue wall on one side only as indicated in Fig. 2. A large damper opening is required to draw the gases around and under the vertical walls and through the flues. The differences noted in the relative openings of 81 to 100 and 101 to 120 is explained by the fact that the ovens No. 100 to 120 are close to the draft stack and receive a more powerful suction, on which account a much smaller opening is required.

By close regulation of the draft a battery of 40 ovens can be brought to a uniform temperature which is very desirable, for if the ovens coke at unequal periods there is a good deal of skipping to be done in pushing, necessitating going over the battery later in the day and pushing the slow ovens. At night a watchman patrols the plant and replaces any defective plastering, which is very evident at night. An important point to watch has been that of securing a uniform slack mixture. It has been

Fig. 5. Sydney Coke as Discharged and Ready for Forking Into Cars for Blast Furnace.

found that slack from freshly mined coal cokes the best and big accumulations of slack are to be avoided, as the sooner the coal is coked after being raised at the bank head, the better is the quality of the coke and the yield of gas. Slack deteriorates at an astonishingly rapid rate, and it has been found very poor practice to use slack from coal banked for any great length of time.

TABLE I.—ADJUSTMENT OF DAMPERS. BERNARD COKE OVENS.

Oven.	Damper Opening, Inches.	Oven.	Damper Opening, Inches.
81	11.	101	4.5
82	2.5	102	5.75
83	5.25	103	4.5
84	6.5	104	5.75
85	5.25	105	4.5
86	6.5	106	5.75
87	5.25	107	4.5
88	6.5	108	5.75
89	5.25	109	4.5
90	6.5	110	5.75
91	5.25	111	4.5
92	6.5	112	5.75
93	5.25	113	4.5
94	6.5	114	5.75
95	5.25	115	4.5
96	6.5	116	5.75
97	5.25	117	4.5
98	6.5	118	5.75
99	5.25	119	2.0
100	6.5	120	10.0

(For Stack Dampers Full Open.)

CHEMICAL AND PHYSICAL PROPERTIES OF SYDNEY COKE.

CHEMICAL ANALYSIS.—The washed slack is very uniform in composition and the average approximate analysis is Moisture—11.54, after drying at 212° F. (Specific Gravity 1.27),

Volatile and Combustible	37.54%
Fixed Carbon	58.34%
Ash	4.12%
	100.00%
Sulphur Content	1.62%

The mineral constituents of coke are of interest especially to blast furnace managers, who, in order to calculate the burden, must consider the acid and basic contents of the fuel. The writer has selected samples of Sydney coke containing a maximum of ash in order to give this data, which is shown in Table II.

If alumina is considered as a base in its chemical action in the blast furnace it will be noted that the coke ash will take care of itself and it will not be necessary to figure it in the ordinary burden calculations.

TABLE II.—ANALYSIS OF SYDNEY COKE.

	Average Analysis 1906.	Average Analysis 1907.
(Dried at 212° F.)		
Volatile and Combustible	2.30%	1.80%
Fixed Carbon	89.95%	90.13%
Ash	7.75%	8.07%
	100.00%	100.00%
Moisture	6.10%	8.00%
Sulphur	1.30%	1.34%
Silica (SiO_2)	1.87%	1.84%
Ferric Oxide (Fe_2O_3)	3.37%	3.64%
Alumina (Al_2O_3)	2.00%	1.88%
Lime (CaO)	.24%	.44%
Magnesia (MgO)	.27%	.27%
Total Ash	7.75%	8.07%

In order to compare the quality of the coke from these ovens with other standard brands the writer has conducted a series of tests from which it is believed a fair and impartial judgment can be passed on Cape Breton coal for the manufacture of metallurgical coke in standard retort-oven systems.

It is found that chemically it compares very favorably with both Connellsville beehive oven "Standard" and other brands of retort oven coke. Connellsville coke, without a double standard the world over, especially for blast furnace work, is used for a comparison with Sydney Mines coke.

It is seen by these analyses that Sydney Mines leads easily in fixed carbon and ash, but has a slightly higher volatile and sulphur content.

Sir I. Lowthian Bell has said that the two chief essential physical requirements in fuel for the blast furnace are hardness of body and well developed cellular structure. The first essential physical requirements of hardness of body is important in protecting the fuel in its downward passage in the blast furnace from loss in dissolution by carbon dioxide. Sir I. Lowthian Bell's observation was a distinct discovery, as he was the first to demonstrate that carbon, as it exists in different qualities of coke, is not influenced in the same degree by this solvent power of CO_2; second, that the soft description, known as black ends, is more easily attacked than the hard, silvery-looking kind. In the second requirements the valuable results from full development of cells in coke are readily understood, as these cell spaces afford free entry to the ascending hot gases, which thus permeates the coke thoroughly and imparts to it a high temperature, which aids materially in its

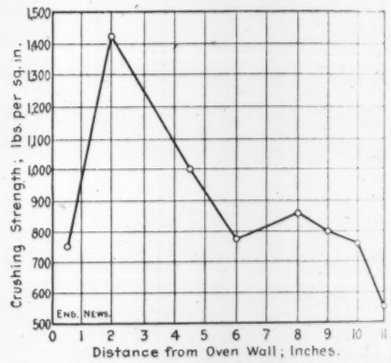

Fig. 7. Curve Showing Decrease in Compressive Strength of Coke with Increase in Distance from Oven Walls.

rapid combustion. It is therefore proved conclusively that the "dissolution" test of Bell and cell structure determinations can be relied on fairly to determine the comparative metallurgical value of different cokes. In the writer's estimation the dissolution test should rank first on account of its showing best of all the behavior of coke under blast furnace conditions. Bell's directions for applying this test in the laboratory are not as clear as one could wish, as he directs that the coke should be pulverized to the size of mustard seed, exposed at a temperature of melting zinc for three-quarters of an hour to a current of CO_2. The standard coke and the sample to be tested are treated exactly the same way and the cubic centimeters of CO measured, but Bell does not say what volume of

TABLE III.—COMPARATIVE ANALYSES OF COKES.

	Dried at 212° F.				
	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulp. Phos.
Sydney mines Bernard.	5.00	2.10	92.3	5.59—1.19	0.009
Connellsvile Beehive ..	0.79	1.31	86.88	11.54—0.62	0.005
Connellsville Hussner..	0.03	0.51	86.38	13.08—0.63	0.015
Connellsville Otto Hoffman	0.19	2.02	85.60	12.26—0.52	0.006

TABLE IV.—COMPARATIVE DISSOLUTION TESTS OF VARIOUS COKES.

	Percentage left after treatment.	Percentage soluble in dry carbon dioxide gas.
Sydney Mines Bernard....	90.57	9.43
Connellsville Beehive	91.00	9.00
Connellsville Otto Hoffman	94.50	5.50
Anthracite	96.00	4.00

TABLE V.—CELL STRUCTURE BY SPECIFIC GRAVITY.

	Weight of coke in grams. In air.	Saturated with water.	Water absorbed. grams.	c.	c_1.	Apparent specific gravity.	Percentage by volume of cells.
Test No. 1—Bauer Coke:							
No. 1	13.1000	20.8500	5.750	16.5		0.743	33.2
No. 2	13.5650	21.4214	5.856	16.4		0.752	33.0
No. 3	12.9200	20.9772	8.057	16.1		0.767	44.9
No. 4	11.0627	17.7566	6.693	13.3		0.753	44.2
Test No. 2—Bernard Coke:							
No. 1	14.6099	22.9200	8.310	17.5		0.762	42.7
No. 2	9.2896	15.6551	6.365	11.7		0.747	48.1
No. 3	12.8352	22.8502	10.015	17.7		0.774	50.5
No. 4	11.0026	19.8096	8.807	14.5		0.7990	51.1
Test No. 3—Bernard Coke:							
No. 1	16.3046	21.3598	5.055	15.5		0.9507	38.8
No. 2	8.3279	14.1778	5.849	11.0		0.7757	47.9
No. 3	9.9602	16.8664	6.906	12.5		0.7411	47.6
No. 4	5.8500	9.7774	3.927	7.5		0.7691	46.7
No. 5	5.6300	9.4511	3.821	7.5		0.793	45.5
No. 6	11.0376	18.5800	7.542	14.1		0.759	47.2
No. 7	9.1799	16.0099	6.830	12.5		0.780	50.6
No. 8	9.0446	16.0258	6.981	13.0		0.6811	50.2
No. 9	7.6159	13.8800	6.265	11.0		0.792	48.1
Average percentage by volume of cells							45.8
Average true specific gravity							1.731

TABLE VI.—COMPARATIVE CELLULAR STRUCTURE.

	Percentage by volume of cells.
Sydney Mines Bernard	45.8
Connellsville Otto Hoffman	50.82
Connellsville Beehive	56.07

CO_2 must be passed. This lack of detail puzzled the writer a great deal, because the more CO_2 passed the greater the CO produced, besides, as the exact size of mustard seed were unknown, it might have been that of the common or garden variety or it may have been that of the pure food sort.

MODIFIED DISSOLUTION TEST.—The following is the writer's method for applying the above. A sample of coke having been selected is crushed to a coarse powder and dried at 212° F., on a water bath, the moisture noted and then the coke is crushed down to pass a 20-mesh sieve and be retained on an 80. The dust being removed through the 80. This is presumed to be what Bell meant for the proper size. The next step was to arrange proper apparatus for the test. A Kipp's apparatus was used to furnish a steady supply of CO_2 and the gas was passed through an Allihn's double-action, gas-washing bottle, filled with strong sulphuric acid in order to get the gas anhydrous. Two methods of subjecting the coke to the stream of CO_2 can be used; the first is to use an ordinary Shimer combustion crucible and the second and more complicated way is to use a 20-burner combustion furnace and a platinum tube. The coke sample should be weighed after careful drying, using 5 grams, and after bringing the crucible or tube to a red heat, pass 400 c. c. of CO_2 over the coke. The amount of CO_2 required can be estimated by allowing the gases to displace acidulated water in a 500 c. c. cylinder over a pneumatic trough. By regulating the stop cock on the Kipp's generator we can pass 400 c. c. in 1 hr., then cooling and weighing the sample and calculating from these data the percentage of weight lost by the dissolution of CO_2.

CELL STRUCTURE.—Tables V. and VI. showing the results of specific gravity tests seem self-explanatory. It should be remembered that the Apparent Specific Gravity of a sample of coke is its relative buoyancy, expressing the relationship between the entire actual mass of material and entrapped air and an equal volume of water. The True Specific Gravity is that of the body of the coke. By Volume of Cells is meant the aggregate of cell space in 100 volumes of coke, or the percentage of cells by volume. The apparent Specific Gravity was obtained by the method of the United States Geological Survey, as given on page 191 of Professional Paper No. 48; Report on the Operations of the Coal Testing Plant at St. Louis, Mo. In the work on which Tables IV. and V. are based the coke was in cubes, sawn as nearly as possible with 1-sq. in. faces and were taken from average samples of Bernard and of Bauer oven products.

TABLE VII.—CHANGE OF CRUSHING STRENGTH OF COKE WITH DISTANCE FROM OVEN WALL.

	Ultimate crushing strength, lbs. per sq. in.	Distance from oven wall in ins.
Test No 1	758	5
Test No. 2	1,418	2.
Test No. 3	1,000	4.5
Test No. 4	773	6.
Test No. 5	858	8.
Test No. 6	800	9.
Test No. 7	768	10.
Test No 8	553	11.

TABLE VIII.—COMPARISON OF ULTIMATE COMPRESSIVE STRENGTH OF COKES.

	Average ultimate compressive strength, lbs. per sq. in.
Sydney Mines Bernard	880
Connellsville Beehive	1,088
Connellsville Hussner	1,548
Connellsville Otto Hoffman	1,128

CRUSHING TESTS.—As retort-oven coke is produced from slack coal charged loose in the long narrow brick cells, designated as ovens, the charge commences to coke at the points of contact with the coal and the incandescent surface of fire brick composing the walls of the ovens. It follows that the coke produced is hardest adjacent to the walls and softer in the center of the oven than at any other point. The progress of coking is therefore from the exterior surfaces of the charge towards the center of the oven. The last volatile matter being driven out of a vertical zone exactly in the center of the oven. The exterior surfaces of the charge are thus subjected to prolonged heating and also have the advantage of a high temperature fusion in which the interior masses cannot participate, being too remote from the walls. Table VII and Fig. 7 resulted from studies of this phenomena sample cubes were tested.

In conclusion, the physical and chemical properties of Sydney Mines Coke produced in retort ovens from Sydney washed slack coal may be summed up viz.:

Fixed carbon contents	6.2% more than Connellsville Beehive
Ash 51.5%	less " " " "
Cellular Structure.. 19.4%	" " " "
Dissolution by CO_2. 4.7%	" " " "
Crushing strength.. 19.1%	" " " "

A PROPOSED RECTANGULAR ELEVATED WATER TANK FOR THE WATER SUPPLY OF CALCUTTA.

Rectangular water tanks, composed of cast-iron plates with flanges for bolting them together, are still being built in England. The plates for these tanks are cast in standard sizes, including curved specials for the corners. To what extent elevated steel tanks are used in England we cannot say, but there has just come to our attention a unique proposition for an elevated steel tank, rectangular in plan, to form a part of improvements to the water supply of Calcutta. Plans for these improvements have been made by Mr. W. B. McCabe, Chief Engineer. We reproduce from the "Indian and Eastern Engineer" for December, 1907, Mr. McCabe's own description of the proposed tank, except that we have slightly abbreviated it in unimportant details.

Briefly, the reservoir consists of a steel tank, 15 ft. deep, 321 ft. sq., supported on steel columns, the height from the top of the tank to the ground level being 110 ft. The tank is divided into four compartments, which can be used independently of each other, so that one or more compartments can at any time be thrown out of work for repairs or cleaning, without any interruption in the supply of water to the town.

Provision for expansion and contraction is made by leaving the bottom flexible, so that the only effect of changes in temperature will be that the slight sagging of the bottom, which will take place between each pair of the supporting joists, will slightly increase or diminish as the temperature rises or falls. This will eliminate all tendency to creep. The 60-in. pipe, which will act both as an inlet and as an outlet pipe, will be fitted with an effective expansion joint. To protect the water from possible contamination and to keep it cool, the tank will be provided with a flat terrace roof, consisting of 2⅝ ins. of fine concrete carried on slates laid between steel rafters, which in their turn are carried on steel joists supported by steel columns from the bottom of the tank. To make the roof water-tight a sheet of Callender's bitumen will be laid over the whole area between the slates and the concrete, and to prevent birds entering the tank through the ventilating spaces, all means of ingress will be closed by brass wire netting of small mesh.

The maximum load on each vertical member of the substructure of the tank will be 200 [long] tons, thus giving a maximum load of 800 tons on each of the sets of four braced verticals. Under each vertical member is a shoe for distributing the load, and reducing the weight per square foot on the surface of the concrete under each vertical member to 6 [long] tons per sq. ft. The load on the soil under the concrete foundations will only be about 0.6 [long] ton per sq. ft., which leaves a large margin of safety even in bad ground such as exists in Calcutta.

The important matter of the foundations of the tank has naturally received much attention, and the design now put forward is the best and safest that could be devised. The site contains a number of old tanks; those which are beneath the foundations are to be dewatered, piled and filled in with jhama khoa well rammed, while tanks which are on or near the edge of the foundation are to be piled, where necessary, and filled in with jhama khoa or earth, and a retaining wall constructed to prevent any lateral displacement of the soil beneath the foundations. The west side of the foundation, next the existing Tallah reservoir, is also to be piled throughout its length. This work completed, it is proposed to level the site and lay down khoa, which will be rolled down by a steam roller as if a road were being constructed. Khoa will be added where necessary, until the steam rollers leave a hard level bed upon which the foundation proper will be laid. The foundation itself is on the grill reinforced concrete system, and consists of a bed of concrete 2½ ft. thick, reinforced at its base with a system of flat ties which cross each other at right angles beneath the supporting columns of the tank. Near the surface of the concrete bed, a system of steel joists is to be built in, corresponding exactly to the system of flat ties below, and upon these joists the bases of the columns will rest. The whole foundation forms a system of which the ties become the lower or tension members, and the joists and concrete take up the compression, and spread the weight over the whole area of the foundation. As an additional precaution, a dwarf wall is to be constructed completely surrounding the tank, extending from the surface of the concrete foundation to a depth of about 4 ft. below the foundation level. This wall will be of concrete, reinforced with expanded metal, and will form the outer edge of the foundation. The foundation is a costly one, as the whole of the concrete will be in cement, but, in view of the paramount importance of the foundation and the known deficiencies of the soil of Calcutta, the expenditure is justified.

EFFICIENCY TESTS OF A DIESEL MOTOR of 200 HP., driving a direct-coupled three-phase generator, in the power-plant of the Berne (Switzerland) foundry of the L. von Roll Iron Works, showed the following results, according to a report by Prof. G. Weber in the "Schweizerische Bauzeitung." Fuel used, petroleum residuum. Fuel consumption, in pounds per kilowatt-hour at switchboard, 0.62 at maximum load, 0.62 at rated load, 0.66 at ¾ rated load, 0.77 at half rated load, 1.42 at ¼ rated load. The generator efficiency varied from 91.5% at full load to 77.5% at ¼ load, including friction and ventilation losses at 1% of full load. The thermal efficiency based on effective horsepower was computed as 33.6% for rated load, 32.4% for ¾ load, 28.7% for half load, and 18.7% for ¼ load, while the thermal efficiency based on indicated horsepower was 47.3 to 44.1%, being maximum at half load.

THE MISSOURI RIVER BRIDGE of the Chicago & Northwestern Ry. at Pierre, S. Dak., on its new line to Rapid City, is an example of modern heavy first-class railway bridge work. It consists of four fixed spans of 350 ft. c. to c. of end pins, and a draw-span of 445½ ft. c. to c. of end pins; the draw is the second span from one end. There are about 606 ft. of timber trestle approach at the east end, and 48 ft. at the west end. The foundations extend about 87½ ft. below rail level, and carry piers of stone masonry. The depth of water in the river varies from 1 ft. to 18 ft., and the rails are 20 ft. above high-water level. The trusses are 18½ ft. apart, c. to c., and their middle depth is 72 ft. for the draw-span, and 58½ ft. c. to c. of chords for the fixed spans. These latter spans have 12 panels, with the top chords curved for the four panels at each end. The bridge is designed for a load consisting of two engines of Cooper's E-50 class, followed by a train load of 5,000 lbs. per lin. ft. of track. The draw is operated by a 40-HP. Otto gas engine, running at 220 r. p. m., and has a masonry guard pier and ice-breaker on the upstream side. The work was under the direction of Mr. E. C. Carter, Chief Engineer, and Mr. W. H. Finley, Assistant Chief Engineer, with Mr. F. H. Bainbridge as Engineer-in-Charge. The contractors were Arthur McMullen & Co., of New York, for the substructure, and the Pennsylvania Steel Co., of Steelton, Pa., for the superstructure. The bridge was completed on Oct. 4, 1907.

HANDLING HEAVY ARMOR-PLATES FOR A BANK VAULT.

A rather difficult job of hoisting and handling was involved in the construction of an armor-plate bank vault for the Carnegie Trust Co. in New York City recently. The vault is composed of sections of armor-plate weighing from 6 to 29 tons, a total of some 1,200 tons of plates, and about 120 tons of castings; it is located in the basement and sub-basement of the office building of the Trust Company of America, at Broadway and Cedar St. The plates were brought to the New York water front by lighter from the railway yards in Jersey City, lifted by the lighter's derrick upon heavy trucks and teamed to the building. Here the problem was to move the plates from the trucks into the basement of the building safely and expeditiously, especially with regard to minimum length of interruption of street traffic.

Broadway being a main artery of traffic was hardly available as a place for the unloading operations. An opening was made in the Cedar St. sidewalk for lowering the plates directly down into the sub-basement. Cedar St. is one of the narrowest of the old downtown streets of the city, being only 40 ft. wide between building lines and only 16 ft. between curbs. As it also slopes down from Broadway on a fairly steep grade, it was anything but convenient for the work.

Over the sidewalk opening a heavy rocker frame was built. This consisted of two 12 × 14-in. yellow pine uprights 15 ft. apart, resting on wooden cradles and capped with a 14 × 14-in. yellow-pine headpiece, being braced by pairs of 4 × 10-in. bracket diagonals. Three heavy tackles were hung from the headpiece. The cradles were set close to the building line, and the frame leaned forward under control of two sets of blocks and falls leading horizontally backward to a timber in one of the second-story rooms of the building. It could thus be slacked off so as to bring the headpiece over a truck standing in the street, or tipped up to bring the headpiece over the sidewalk opening.

The truck carrying a plate being brought up Broadway, to the corner of Cedar St., the leading horses were unhitched and fastened to the rear of the truck to hold back the load going down the Cedar St. grade, thus bringing the truck into position along the curb under the rocker frame. The plates were up to 10½ ft. wide and up to 22¼ ft. long. Lying parallel to the curb, on the truck, they had to be lifted off, turned to bring their length transverse to the street, and tipped up so that they could be lowered through the sidewalk endwise. This entire handling was done by the three fall lines as follows: The lines from the two ends of the headpiece were attached to the sides of the plate, a little one side of the middle, while the central line was attached to the farther end of the plate. The lines attached near the middle of the plate thus had a quarter twist relative to each other, and by hauling in the rocker frame, which raised the load clear of the truck, they acted to swing it around a quarter turn. Then, by slacking off the end line, the plate was lowered at the end toward the building to a nearly vertical position, so that it could be lowered down into the sub-basement. Here it was turned around again into the desired position, and by means of other lines and rollers it was moved to its proper location in the vault.

FIG. 1. THIRTY-TON VAULT PLATE ON TRUCK.

This arrangement worked so successfully that the whole time required for handling a plate, from the time the truck arrived at Broadway and Cedar St. until the plate was in the sub-basement, was only 15 to 20 mins. The heaviest plates are the front and rear door frames, which weigh 57,500 lbs. each. One of them is shown on its truck by the photograph Fig. 1 herewith. Fig. 2 herewith shows the headframe with its lines attached to a plate ready to raise it from the truck. The construction of the frame and the attachment of the lines is clearly apparent in this view. The rigging was designed and constructed by the Alfred E. Norton Co., of New York City, who were the contractors for the erection of the vault.

THE BRIDGES OVER THE ALLEGHENY RIVER between Allegheny and Pittsburg need not be raised, according to a decision of Secretary Taft last week. The river navigation interests demanded that the bridges be raised because at high water vessels cannot pass under them. The bridge companies contended that this would be unfair and would impose a burden on all traffic passing over the bridges.

COST REDUCTION FOR MANUFACTURING PLANTS.*

By MAURICE GESUNDHEIT,† C. E., M. ...

Ever since competition first made its appearance in the field of industry, nothing, of course, was quite so dear to the heart of the manufacturer as the increase of his earnings by means of reduction in the cost of his product; hence Cost Reduction has always been recognized as the most important factor in industrial enterprises. Yet, strange to say, until quite recently, few have realized that the only positive benefit to be derived from Cost Reduction is the comparative advantage it furnishes over competitors. Thus suppose that the wages scale of machinists should be reduced by 25%, or the market price of pig iron should drop to $12.00 per ton; this will undoubtedly reduce the cost of production, but will it also benefit the individual manufacturer? Hardly, for his competitors' product will be cheapened to the same extent as his own, and the law of supply and demand will see to it that the margin of profit be not excessive.

It is for this reason that while the old-time manufacturer, owing to lack of competition, succeeded as well by the simple means of cutting the wages of his working forces, of purchasing his material in the most advantageous market and of generally keeping down expenses; the more modern captain of industry can no longer follow in the footsteps only, but must resort to other expedients in order to achieve the same results. Hence we find him making strenuous efforts to reduce costs by various measures, all of which can be grouped under four main headings:

(1) Improvements in Buildings, Machinery and Equipment.

(2) Introduction of devices for lowering the labor cost of various operations and of increasing the output of the working forces.

(3) Adoption of methods for the more intelligent and more thorough control of the interior conditions.

(4) Acquisition of more knowledge relating to efficiency and cost of production.

Under the first heading of improvements in Buildings, Machinery and Equipment, the mechanical or betterment engineer finds himself in his element. He designs new buildings with plenty of light and heat, good ventilation, lots of headway and broad aisles for industrial tracks. He introduces automatic machinery and special tools; multiple drills and portable drills; horizontal boring mills and vertical slotting machines; he adopts individual and group motor drives, electric cranes and pneumatic hoists. He applies self-hardening tool-steels, and automatic tool grinders. He makes use of all kinds of jigs, templets and gages. In a word, he introduces all the physical betterments that the development of mechanical knowledge presents.

*A paper read before the Metal Manufacturers' Association of Philadelphia, Dec. 19, 1907.—Copyright, 1908, by The Gesundheit-Osgood Co.

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Under the second group, devices for lowering labor cost and increasing the output of working forces, we see the superintendent active in applying piece-work, premiums and bonuses; in having resort to contract work and gang work; to suggestion boxes and prize awards, to inspection and penalties; or we find him busy with the regulation of speeds and feeds and the determination of cutting angles. We see advantage taken of the principles so cleverly evolved by Mr. F. W. Taylor, or again of Mr. Hawley's ideas, or of the different views advanced by other students of the labor problem.

Under the third heading, methods for more intelligent and more thorough control of interior conditions, we find the shop accountant or modern methodizer busily occupied devising methods for regulating stock, raw, in process and finished; for following shipping orders through their various movements; for handling stores and stock; for recording time and compiling pay-rolls; for taking care of incoming material and outgoing shipments; for handling drawings and blue prints, patterns and core boxes; for ascertaining the resultant spoilage and waste; for assuring prompt shipments; for correct ways of recording and handling of orders, purchases and shipments, and many other ways through which clerical effort can be directed towards intelligent control of business.

Finally, under the fourth group, acquisition of more knowledge relating to efficiency and cost of production, we see the manufacturer making an earnest endeavor through his own efforts, or more frequently through an outside cost specialist, to devise a way by which he can ascertain the cost of each product he manufactures, not infrequently of each component part thereof, and occasionally even of each individual operation. Those he compares with previous records and finds out the efficiency of his establishment. He goes a step farther and finds the efficiency of individual departments, sometimes even of individual workmen and individual tools.

Right here permit me to say that the lack of correct information as to costs is the most baneful factor a manufacturer has to contend with in unintelligent competition; for strange as it may seem, the average manufacturer, who is otherwise a clear-headed and far-sighted fellow, generally guesses his costs on the wrong side of the fence; he will usually figure closely on his material or labor, but form a snap judgment of his overhead expenses, forgetting frequently to take into consideration some of its most important factors, such as depreciation for wear and tear, interest on investment, advertising and selling expenses, or losses on collections.

Again, in the establishments where cost-finding methods are in existence it is rarely that the results they furnish are reliable and helpful. In the many factories where I have had occasion to observe costs it has been the exception to find them satisfactory from the standpoint of good business. In many cases the labor data, and sometimes the material information is misleading; in others, and this is a frequent occurrence, the overhead expense or burden is erroneously applied; in others again, some items of this expense are overlooked, or else the information compiled in a manner that makes it past history, and hence but of little practical value.

However it may be, the above in a general manner describes the measures the modern manufacturer has taken towards Cost Reduction, and we must admit that, broadly speaking, he has succeeded well.

The question that one naturally asks is: Has the manufacturer utilized these agencies to his best advantage? Has he, in view of the fact that he cannot always make use of all of them,—has he, I repeat, chosen those best suited to existing conditions, and having determined on them, has he taken care that they do not run away with him? I am sure I have you with me in answering in the negative. The recent financial hysteria, through which the country has just passed, the business depression from which I am glad to say we are rapidly emerging, is due not a little to the unreasonable expansion of our varied industries during the last decade. The country being prosperous, orders rushing in beyond the plant's apparent capacity, made the manufacturer naturally eager to reap all the benefits of the unusual prosperity, and in his anxiety to meet the requirements, he proceeded to energetically increase his plant; he invested in brick and mortar, in machinery and equipment, losing sight however of the fact that the tremendous demand was abnormal and could not possibly continue indefinitely. Engrossed in the betterment and expansion of his factory, he even ignored the possibilities that existed for increasing his output by internal changes and improvements in manufacturing and in methods. The result was that heavy indebtedness has been assumed by many industrial concerns which, with stringency of credit and decrease in orders, they could not readily shoulder. Plants which otherwise might have been running on smoothly and prosperously find themselves crippled as a result of their near-sighted policy.

Sad as these conditions may be, it is no less so to see all over the country misdirected capital spent in certain betterments which, if used conservatively and judiciously and directed into other channels, might have produced results of infinitely greater benefit.

Take for instance a large manufacturing concern which has recently removed its plants from Pennsylvania to New York. It tore down its buildings, dismantled its machinery, most of which was thrown on the scrap-heap, and spent a fortune in replacing them on the new site with modern buildings and better equipment. In the meantime production had to stop; orders had to be turned away, until now, I suspect, it has good reasons for regretting its rash move for betterment.

Or consider again a large machine-manufacturing concern in the suburbs of Boston. It permitted itself to be carried away with the betterment idea to such an extent as to spend a pile of money on a superb fireproof building for pattern storage, with every conceivable modern improvement; yet its entire plant is suffering because of its foundry being utterly inadequate for its requirements. Its method of handling iron, coke and sand is primitive and most expensive; its finished castings are strewn all over the yard, where they are eaten up by rust and where they can be located only with difficulty. Evidently, in that case, if the amount expended on the exceptional pattern warehouse were used for improvements in the foundry and for a sensible inexpensive shed for storing castings, the concern's interests would have been much better conserved than at present.

Fig. 2. Rocker Frame for Unloading Plates for Vault of the Carnegie Trust Co., Cedar St. and Broadway, New York City.
(A. E. Norton Co., Contractors.)

In the same way we see also individual tool drive introduced where the advantage derived therefrom is so small as not to justify the expenditure involved. We see special machinery purchased, fine for the purpose intended, but the work for it so scarce that it cannot possibly pay for the interest on its investment, or for its depreciation and maintenance charges.

Manufacturers are prone to forget that often that which may be the best thing in the abstract is by no means the best thing under given conditions; and no matter what improvements are possible in the form of new buildings and equipment, the best dividend-paying policy may often be to abstain from large expenditure, but to develop the earning power of a plant, as it exists, without additional expense, by making use of one or more of the ways and means enumerated above.

Thus, it seems to me that our automobile industry is suffering largely from this very betterment impulse; and it is not hard to foresee that until it has learned to rest on what is practical and satisfactory, to standardize its product in its entirety and in its parts, to make changes cautiously and only when experience has proven them imperative, and even then adhering as much as possible to the original design; until then, I repeat, it will lack the stability and firmness so essential to its permanent success.

In this respect one might take a lesson from the New York Central Railroad, which, in these days of railroad criticism can perhaps bear a word of praise. Quite a few years ago it went to great expense in fitting up in luxurious style two fast trains to run between New York and Buffalo, known as the Empire State Express. As years passed by, numerous improvements and innovations were introduced in the construction of Pullman and dining cars, so that these trains might well be considered as antiquated. Has the railroad management discarded them, has it replaced them by new, more modernly equipped trains? No indeed. It realized that the earning power of the old ones has by no means been exhausted, and that therefore it would be poor business policy to consign them to the scrap heap; and so the same trains are still in daily service to the satisfaction of their patrons and to their own profit.

Let us now turn to the subject of Labor Control and Increase of Shop Production. Here as elsewhere, I regret to say, we find favorite hobbies allowed full sway, with the result of their frequently defeating their own object. The manufacturer nowadays usually appreciates the benefits to be derived from some form of piece-work, but unfortunately he is inclined to plunge into it without proper preparation; without a study of his conditions, his equipment, the personal equation of his working forces. Is it then surprising, I ask, to find him frequently failing, more or less, in this attempt and obtaining but a part of the benefits possible under the more skillful application?

I happen to know a concern, perhaps the largest of its kind, which has a most profound contempt for piece-work, indeed almost a dread, and yet I know that its labor costs are excessive and could be considerably reduced by this means. What is then the reason of their antagonism to piece-work? Simply this: they tried it once in an unscientific manner, and, as was to be expected, fell down on it badly. Their chief executive, a man of determination and great energy, not realizing, however, the scientific nature and far-reaching scope of piece-work, enthused suddenly on this phase of the labor question, and insisted that the entire plant employing several thousand hands be put on a piece-work basis without delay, giving only a short time to prepare for the change; the prices set were arbitrary guesses, no provisions were made for inspection; the result was that the product turned out was so unsatisfactory as almost to ruin their otherwise enviable reputation and desirable trade.

Other manufacturers fail to realize that no matter how good a piece-work system may be, its success depends largely on its tactful and careful introduction. I know of several cases where a thoroughly good piece-work scheme failed, because it was unduly pushed on the workmen who were not properly prepared for it and could not therefore comprehend that it would redound to their own benefit. But beyond any question, the most grave mistake that the manufacturer is apt to make in regard to piece-work is the breaking of faith with his help. Unfortunately few employers can look on complacently when their workmen increase their earnings above, say, 25%, and when this point is reached a cutdown in the piece-price is the established rule. But what are the consequences? The very object sought for—reduced labor cost—is entirely defeated, since the workmen, readily realizing that their efforts to earn more are used as a weapon against themselves, to compel them to work much harder in order to earn what they are accustomed to, soon band themselves together and see to it that they produce no more than enough to earn the permissible amount. The loser in that transaction is evidently not so much the workmen as the manufacturer himself; he has no way of learning what the real capabilities of his men or tools may be; and therefore has never at hand this means for ultimately reducing his labor cost; at the same time his production is curtailed and his overhead expenses are maintained high since they are spread over a reduced volume of output. On the other hand, had he kept faith with his workmen and permitted them to make as much as they could, his labor costs would have been no higher, his volume of product would have been increased, his general expenses would have been lowered, and what is more, he would have learned what a fair price for each piece of work may be, and thus he would have been enabled, at the opportune time, to reduce it to the proper level. For it will be readily admitted, that give a man a long enough time in which to reap the benefit from his extra efforts, and the consideration that the price may be cut afterwards will not deter him from making hay while the sun shines.

Only recently a Pittsburg manufacturer informed me that he was busy with a large contract on which he was under a heavy penalty for each day's delay in delivery; he urged his men, who were on piece-work, to rush with their work, promising not to cut prices, no matter how much they might earn; notwithstanding all his endeavors, however, he could not induce them to do more than about half of what he knew they were capable, and mind you, his was an open shop. When I asked him if he ever cut prices arbitrarily, he admitted that his practice was to reduce prices whenever the men were making too much money. I did not wonder than that his men lost faith in him and refused to do their best on the strength of his promise. I ad-

vised him, however, to make a public statement on the bulletin board over his own signature, to the effect that all piece rates, from now on, will be guaranteed to remain in force for a period of not less than six months, irrespective of what the individual earnings of the men might be. Admitting that this would surely solve his difficulty, he proceeded forthwith to put this principle into active operation.

However, it must be recognized that not only in simple piece-work but in all endeavors to regulate labor and to increase output, the grave mistake is frequently made of applying good principles to conditions which they do not fit.

Take for instance the well-known Taylor System, based on unit of operation, detailed instructions as to speed and feed, definite time allowance, functional foremen and high remuneration to skillful machinists. We all highly appreciate the far-reaching character of Mr. Taylor's labors and have great respect for the importance of his achievements; but I maintain that we must not permit the beauty of his theory to carry us off our feet. We must, in justice to ourselves, recognize its inherent limitations and realize that to apply it indiscriminately to every plant and under all conditions would be a grievous and costly mistake. I think you will all agree with me that the attempt to run on the Taylor System a medium-sized jobbing shop doing light machine work would result only in its inability to secure business on a competitive basis; since the cost of installing and maintaining the system, when the jobs are of varying nature and of short duration, would outweigh severalfold any advantage that may be derived from its application. But we also must recognize that there are many other conditions, under which its adoption cannot but affect profits adversely. The very fact that its success depends so largely on each man completing his task on the tick of the clock, his too early finishing being as antagonistic to its central idea as his belated ending, which you will admit, comes mighty close to what our questionable friends the labor union men also delight in; again, its requirements of a complex organization of functional foremen, each with an assistant or substitute, to avoid any break in continuity of manufacturing; its dependence on highly skilled workmen who are nevertheless prevented from using in their own work either judgment or initiative; all these facts, it must be admitted, make its unrestricted application desirable only under most unusual and favorable circumstances.

Similar difficulties are encountered in the general adoption of any other mode of labor remuneration and control. The system of contract labor, for instance, has been abandoned by most manufacturers, since it has been recognized that under such an arrangement the boss stands all to gain and nothing to lose, and usually makes a big profit without working hard for it; and yet I know of some large concerns that continue to use this mode of labor to the almost entire exclusion of any other. Why? Because it is a hobby ridden so long that it is almost impossible to displace it.

Coming down to Inspection, by no means an unimportant factor in the organization of certain industries, we find it also frequently misused. Instead of assuring correctness of manufacturing, smooth-running continuity, and prevention of expending additional labor on an article already spoiled either by faulty work or inherent defects, we often find it developed to abnormal dimensions, overshadowing every other function of shop organization and, instead of helping, only obstructing its progress; or else we find a lamentable lack of inspection methods, with the resultant incessant complaints of customers and considerable loss of money and prestige. Thus I know one of the foremost industrial concerns of this country where the high-handed and arbitrary attitude of the inspecting department costs the company many thousands of dollars annually; just as I know another concern in New England whose business rests entirely on its reputation, which it was in great danger of losing simply because it had a system of inspection which not only did not encourage the inspectors to reject its defective product but actually penalized them for doing so.

Turning now to the third important division, that of Shop Methods, we all know of the amazing progress made in them during the last score of years. We are all aware that many a concern now standing at the top of its industry owes its position pre-eminently to the excellence of its methods and to the solidity of its organization. Yet, at the same time, we also know that in a number of other industrial establishments attempts made at effective systematization have turned out dire failures. One naturally asks therefore, what is the reason for striking successes on the one hand and ignoble failures on the other? The reply, in my opinion, is simply this: Nothing can be successfully constructed from the top down, but everything must be built from the ground up. Shop method, no less than a fine complex building, must rest on a secure and deep foundation from which it must be carefully and understandingly reared up, step by step, by someone who thoroughly understands not only the nature and peculiarities of the manufacturing conditions, but also their relation to the engineering, accounting and business problems of the concern. Where this has been done, the success that followed was evidenced by the rapid stride of progress and corresponding profits of the concern. But when a manufacturer, not realizing the above facts, intrusts his plants to the hands of a mere accountant-systematizer, an individual who, perhaps, has no personal experience of manufacturing conditions, whose knowledge of shop methods consists chiefly of book-learning; who starts to build from the top down, from the office downwards toward the shop; who takes no cognizance of complex conditions which cannot be safely ignored—when such a person is let loose in the intricacies of a shop, is it surprising to find that the result of his labor is but a mass of red-tape tying everything up in a hard knot and adding only unnecessary expense and confusion? I know a concern which, having employed the services of such an accountant-systematizer and after having his ideas installed, being compelled to cast them out, complained to him of the paucity of his results. His excuse was that had they followed his instructions to the letter everything would have turned out all right.

I do not wish to be understood as condemning all work done by accountants or systematizers: there is a field in which they do splendid work and in which they are indispensable. I deplore the fact, however, that some manufacturers, failing to differentiate between them and the practical workers in shop management, often expect of the former results entirely beyond their ken or province, and being disappointed in them, are prone to condemn with them all other outside specialists.

When we approach the question of Cost finding, we see here too great strides of progress made during the recent years of industrial expansion. Manufacturers, as a rule, are no longer satisfied with rough approximations of their costs. They demand to know the cost of each specific product, and realize that, in the face of strenuous competition, it is no longer safe to add an arbitrary percentage for general expenses. It has become customary nowadays, as I mentioned before, to ascertain the costs of not only each product, but each part and even each operation, and to segregate the overhead expenses by departments or processes. Indeed, I know of a very prominent concern, manufacturing several classes of machines, which, in its anxiety to obtain reliable costs, has gone to the extreme of physically separating each class of its product, to which end it spent a considerable amount of money in increasing its buildings and duplicating its equipment, so that each of its lines of product may be built entirely under a separate roof.

The question is, is that not going a little too far? Is it not sacrificing all the advantages of concentrated manufacturing and specialized organization for the sake of getting more accurate cost-data? Is the game worth the candle? I believe you will agree with me, that to say the least it is questionable. Yet how many excesses are committed in the name of costs! How often do we see the foremen, instead of attending to their men and their work, spending most of their time over pretty forms and a variety of records; how frequently do we find the workmen waste anywhere from 15 to 30 minutes each day making out job or time cards, and all for the benefit of the Cost Department! If the manufacturers could only realize the effect of such conditions on the output and efficiency of their plant, I am sure that in some cases they would prefer close estimates to correct costs obtained at such a sacrifice.

Again, there are concerns, which month in and month out, year in and year out, collect the details of their costs in a most laborious and expensive manner, and yet their costs remain practically stationary, and the changes that *do* occur are so self-evident as to be ascertained in an inexpensive manner, independent of their cost system. Thus I am familiar with a prominent Eastern concern, producing a number of practically standard machines, which spends yearly a fortune in collecting detailed costs by parts and operations, and in doing so has to seriously interfere with its volume of output. And what use do you think they make of this data obtained at such expense of money and effort? You would suppose they would try to discover by their means the causes for the fluctuation in costs and to maintain conditions yielding the best results. But nothing of the kind. They use their figures principally for the purpose of averaging up and in such a manner as to obtain costs closely approximating those compiled during years of previous cost-finding experience.

On the other hand, in industries where accurate costs are too expensive to be attempted, it is a frequent occurrence that no attempt whatever is made at costs, and a rough estimate is the prevailing rule. This is just as bad as too much cost-system. The principle of averages differentiated scientifically to suit the nature of the product could in most of their cases be utilized to great advantage.

But perhaps the most prevalent defect of cost-finding schemes I have observed is a marked lack of agreement between them and the financial accounting. What I mean is, that the net profit calculated on the basis of costs and sales most frequently in no way agrees with the profit as shown by the financial account. This is due to various causes, among which may be mentioned the oversight of some important element of expense or loss; the difference between the prices which material is received and charged out; and the lack of a proper method for taking care of spoilage and waste, and of returned goods.

While on this subject, it may be well to caution here that in metal manufacturing plants making a variety of products the most suitable system of finding is generally the one based on the unit of machine expense. The objection, however, which presents itself to such a method is the difficulty of approximating anywhere near the correct rate for the manifold tools, whence a great discrepancy usually results at the end of the fiscal year between the figured and actual costs. A scheme, however, can be adopted which by means of a compensated percentage can entirely overcome this obstacle. That percentage should then be devised to absorb all the elements of expense not directly traceable to the individual tool, and should be distributed either over the time of machining, or preferably, over the cost of labor.

And thus we see that while the various devices for Factory Cost Reduction all contain a good deal of what is good and helpful to the manufacturer, yet like most of them have been frequently mistreated, either having been made use of too much or too little, and usually not employed to the best advantage. What is the reason? Simply this. Modern concerns find it necessary to place at the head of the several controlling departments specialists, each one to look after one particular feature of the business. These men, to be worth while, must be enthusiasts in their work, and however proficient in their special field they may be, they, as a rule, know but little of the other branches of the business; the result being that each one injects into it his own views, his own ideas, his own preferences, but without due regard for their effect on the other branches of the enterprise which he neither understands nor greatly sympathizes with; consequently, there exists a dire and costly lack of the all-important co-ordination, without which the highest standard of efficiency is unthinkable.

The remedy is this: The chief executive, who of late, busy with organization and policy, has left much of his business in the hands of his subordinates, must once more put his shoulder to the wheel; he must now educate himself to thoroughly grasp the technical features of his business, not in the detailed way, as during the one-man-business regime, but in their larger aspects. He must be fully qualified to act as arbiter and to intelligently determine what innovations are desirable in the various directions and to what extent should they be permitted to be undertaken. It is only where there is thus combined in a single mind the full grasp of the inter-relations of all the broad aspects of the business that Cost Reduction can achieve its highest development and net earnings be duly raised to their highest standard.

A STATE INDUSTRIAL COLLEGE designed to fit men already experienced in the shop for positions as foremen, superintendents and overseers is recommended by the Massachusetts Commission on Industrial Education in a report on Feb. 22. The following is quoted from the commission's report.

The commission recommends that the Legislature of 1908 authorize the establishment of an industrial college of the type outlined in this report, to be under the control of some designated State authority; further, that the authority thus designated report to the next Legislature the best location for such a college, together with an estimate of the cost of site, erection and equipment of buildings, the annual expense of maintenance, and such other matters relating to the college as seem to it desirable. It further recommends that legislation be enacted making available annually for the equipment and maintenance of an industrial college all sums authorized paid to the State through the appropriation act of Congress of March 4, 1907.

It is not recommended that either the Massachusetts Agricultural College or the Massachusetts Institute of Technology receive in any future year a sum less than that received annually in the past from the national treasury, but does recommend that the educational sums subject to the direction of the Legislature by the national act, to which reference has been made, be directed paid to the Massachusetts Industrial College to be established in accordance with this report.

Today, in the United States, men are not being developed in the industries for the middle and lower supervisory positions. As has been often pointed out of late, the trades are so much divided that even an able man in an industry has an opportunity, as a rule, to learn only one branch or one department of his trade. Such a man may hope to become the head of that particular department if the industry is large enough to warrant the employment of a superintendent for that particular department; but if the supervising is done by a man who has charge of several departments, it is not only impracticable but practically impossible, under present circumstances, for him to fit himself for such a supervisory position. As a result, it has been found impossible for men in lower positions to fit themselves for higher positions from their shop experience alone.

The commission states that such an industrial college should have both day and evening classes, and tuition in it should be practically free to residents of the State, and should be located in Boston or vicinity.

PRELIMINARY REPORT OF THE INLAND WATERWAYS COMMISSION.

On March 14, last, the Inland Waterways Commission was created by President Roosevelt in response to requests from many commercial organizations in the Mississippi Valley that such a commission be appointed to prepare and report a comprehensive plan for the improvement of the river systems of the United States.

A preliminary report of this commission, rendered on Feb. 3, was transmitted to Congress by the President on Feb. 26. We give below in somewhat condensed form the message of the President and the Commission's report:

To the Senate and House of Representatives:

I transmit herewith a Preliminary Report from the Inland Waterways Commission, which was appointed by me last March in response to a widespread interest and demand from the people. The basis of this demand lay in the general and admitted inability of the railroads to handle promptly the traffic of the country, and especially the crops of the previous fall.

This report is well worth your attention. It is thorough, conservative, sane, and just. It represents the mature judgment of a body of men exceptionally qualified, by personal experience and knowledge of conditions throughout the United States, to understand and discuss the great problem of how best to use our waterways in the interest of all the people. If the report errs at all it is by overconservatism.

The Commission finds that it was unregulated railroad competition which prevented or destroyed the development of commerce on our inland waterways. The Mississippi, our greatest natural highway, is a case in point. At one time the traffic upon it was without a rival in any country. The report shows that commerce was driven from the Mississippi by the railroads. While production was limited, the railways, with their convenient terminals, gave quicker and more satisfactory service than the waterways. Later they prevented the restoration of river traffic by keeping down their rates along the rivers, recouping themselves by higher charges elsewhere. They also acquired water fronts and terminals to an extent which made water competition impossible. Throughout the country the railways have secured such control of canals and steamboat lines that today inland waterway transportation is largely in their hands. This was natural and doubtless inevitable under the circumstances, but it should not be allowed to continue unless under careful Government regulation.

The report rests throughout on the fundamental conception that every waterway should be made to serve the people as largely and in as many different ways as possible. Each river system, from its headwaters in the forest to its mouth on the coast, is a single unit and should be treated as such. Navigation of the lower reaches of a stream can not be fully developed without the control of floods and low waters by storage and drainage. Navigable channels are directly concerned with the protection of source waters, and with soil erosion which takes the materials for bars and shoals from the richest portions of our farms. The uses of a stream for domestic and municipal water supply, for power, and in many cases for irrigation, must also be taken into full account.

Forest protection, without which river improvement cannot be permanent, will at the same time help to postpone the threatened timber famine, and will secure us against a total dearth of timber by providing for the perpetuation of the remaining woodlands. Irrigation will create the means of livelihood for millions of people, and supplies of pure water will powerfully promote the public health. If the policy of waterway improvement here recommended is carried out, it will affect for good every citizen of the Republic. The National Government must play the leading part in securing the largest possible use of our waterways; other agencies can assist, and should assist, but the work is essentially national in its scope.

The various uses of waterways are now dealt with by Bureaus scattered through four Federal Departments. At present, therefore, it is not possible to deal with a river system as a single problem. But the Commission here recommends a policy under which all the commercial and industrial uses of the waterways may be developed at the same time. To that end, Congress should provide some administrative machinery for coordinating the work of the various departments so far as it relates to waterways.

While we delay, our rivers remain unused, our traffic is periodically congested, and the material wealth and natural resources of the country related to waterways are being steadily absorbed by great monopolies. Among these monopolies, as the report of the Commission points out, there is no other which threatens, or has ever threatened, such intolerable interference with the daily life of the people as the consolidation of companies controlling water power. I call your special attention to the attempt of the power corporations, through bills introduced at the present session, to escape from the possibility of Government regulation in the interests of the people. These bills are intended to enable the corporations to take possession in perpetuity of national forest lands for the purposes of their business, where and as they please, wholly without compensation to the public. Yet the effect of granting such privileges, taken together with rights already acquired under State laws, would be to give away properties of enormous value.

Through lack of foresight we have formed the habit of granting without compensation extremely valuable rights amounting to monopolies on navigable streams and on the public domain. The repurchase at great expense of water rights thus carelessly given away without return has already begun in the East, and before long will be necessary in the West also. No rights involving water power should be granted to any corporations in perpetuity, but only for a length of time sufficient to allow them to conduct their business profitably. A reasonable charge should of course be made for valuable rights and privileges which they obtain from the National Government. The values for which this charge is made will ultimately, through the natural growth and orderly development of our population and industries, reach enormous amounts. A fair share of the increase should be safeguarded for the benefit of the people, from whose labor it springs. The proceeds thus secured, after the cost of administration and improvement has been met, should naturally be devoted to the development of our inland waterways.

The report justly calls attention to the fact that hitherto our national policy has been one of almost unrestricted disposition and waste of natural resources, and emphasizes the fundamental necessity for conserving these resources upon which our present and future success as a nation primarily rests. Running water is a most valuable natural asset of the people, and there is urgent need for conserving it for navigation, for power, for irrigation, and for domestic and municipal supply.

Being without funds or an expert staff, the Commission has confined itself to principles affecting the whole problem and the entire country. Its report is a plea, in the light of actual facts, for simplicity and directness in dealing with the great problem of our inland waterways in the interest of the people. It submits no specific plans or recommendations concerning even the most important projects.

Hitherto our national policy of inland waterway development has been largely negative. No single agency has been responsible under the Congress for making the best use of our rivers, or for exercising foresight in their development. In the absence of a comprehensive plan, the only safe policy was one of repression and procrastination. Frequent changes of plan and piecemeal execution of projects have still further hampered improvement. A channel is no deeper than its shallowest reach, and to improve a river short of the point of effective navigability is a sheer waste of all it costs. In spite of large appropriations for their improvement, our rivers are less serviceable for interstate commerce today than they were half a century ago, and in spite of the vast increase in our population and commerce they are on the whole less used.

The first condition of successful development of our waterways is a definite and progressive policy. The second is a concrete general plan, prepared by the best experts available, covering every use to which our streams can be put. We shall not succeed until the responsibility for administering the policy and executing and extending the plan is definitely laid on one man or group of men who can be held accountable. Every portion of the general plan should consider and so far as practicable secure to the people the use of water for power, irrigation, and domestic supply as well as for navigation. No project should be begun until the funds necessary to complete it promptly are provided, and no plan once under way should be changed except for grave reasons. Work once begun should be prosecuted steadily and vigorously to completion. We must make sure that projects are not undertaken except for sound business reasons, and that the best modern business methods are applied in executing them. The decision to undertake any project should rest on actual need ascertained by investigation and judgment of experts and on its relation to great river systems or to the general plan, and never on mere clamor.

The improvement of our inland waterways can and should be made to pay for itself so far as practicable from the incidental proceeds from water-power and other uses. Navigation should of course be free. But the greatest return will come from the increased commerce, growth, and prosperity of our people. For this we have already waited too long. Adequate funds should be provided, by bond issue if necessary, and the work should be delayed no longer. The development of our waterways and the conservation of our forests are the two most pressing physical needs of the country. They are interdependent, and they should be met vigorously, together, and at once. The questions of organization, powers, and appropriations are now before the Congress. There is urgent need for prompt and decisive action.

Theodore Roosevelt.

February 26, 1908.

Preliminary Report of the Inland Waterways Commission.

The Commission is fully aware that its creation was due to a demand of the people, and that there exists an expectation in certain localities that the report here presented will include plans extending in detail to the principal waterways of the country. To prepare and consider such plans would require extended study at large expense by engineers and other experts whose services were not available. Under the instructions from the President, and in the absence of funds and of the men and time required for such study, the Commission was necessarily confined in preparing this preliminary report to the more general features of "a comprehensive plan designed for the benefit of the entire country."

FINDINGS.

There are in the mainland United States some 25,000 miles of navigated rivers and at least an equal amount which are navigable or might be made so by improvement; there are also some 2,500 miles of navigable canals, and over 2,500 miles of sounds, bays and bayous readily connectable by canals aggregating less than 1,000 miles in length to form inner passages paralleling the Atlantic and Gulf coasts—these being additional to some thousands of miles (reckoned between leading ports) of regularly navigated waters in lakes and landlocked bays. Although it is not probable that any considerable share of this vast mileage of navigable waterways will be improved to a high standard of efficiency at least at an early date, yet the assured growth of the country and the capacity of these waters not only for navigation but for other uses render imperative the necessity for their control and utilization as an asset of almost unlimited value.

Railway Competition.—While the decline of navigation in the inland waterways was largely due to the natural growth and legitimate competition attending railway extension, it is also clear that railway interests have been successfully directed against the normal maintenance and development of water traffic by control of water-front and terminals, by acquisition or control of competing canals and vessels, by discriminating tariffs, by rebates, by adverse placement of tracks and structures, and by other means.

Since railways reach all parts of the country while navigable waterways are confined to certain natural lines, it is clear that railways can so control transportation as to leave the waterways insufficient traffic to support the requisite vessels and terminals. So large a portion of railway traffic is free from water competition that railways can readily afford to so reduce rates on those portions affected by such competition as to destroy the profits of the water lines without appreciably affecting the profits of the rail systems which recoup these reductions by higher rates elsewhere. It will not relieve traffic congestion to improve our waterways unless the improved waterways are used; hence it is obvious that relief from the existing congestion by waterway improvement can be made permanently effective only through such coordination of rail and water facilities as will insure harmonious cooperation rather than injurious opposition.

Purification.—Improvements of navigation in inland waterways in the main affect favorably the purity of the waters and the regularity of the supply, and these objects should be carefully kept in mind. The increasing pollution of streams by soil-wash and other waste substances connected with a growing population reduces the value of the water for manufacturing purposes, and renders the water supply for communities injurious to and often destructive of human life. The prevention of these evils should be considered in any scheme of inland waterway improvement.

Regimentation.—Engineering works designed to improve navigation affect favorably the regimen of the streams, including floods and low waters. The annual floods of the United States occasion loss of property reaching many millions of dollars, with considerable loss of life, while the low water of late summer involves large loss in diminished water supply, in reduced power, and in the fouling of streams, with consequent disease and death. It has been claimed that in specific cases the cost of works required both to control floods and meet the needs of commerce would be less than the amount of this loss. It is desirable that more detailed information be collected concerning the effects of floods and low waters and their prevention by engineering works and other devices.

Erosion.—The annual soil-wash in mainland United States is estimated at about a thousand million tons, of which the greater part is the most valuable portion of the soil; it is carried into the rivers, where it pollutes the waters, necessitates frequent and costly dredging, and reduces the efficiency of works designed to facilitate navigation and afford protection from floods. The direct and indirect losses from this source have not been

measured, but are exceedingly large; and it is desirable that definite determinations be made with the view of devising means for reducing the loss to the land and preventing the impairment of the streams for purposes of commerce.

Cultivation.—Both the regimen of streams and the purity and clarity of waters are affected by forests and other natural growth, and by farming, mining and other industrial operations over the watersheds in which they gather. Millions of acres in mainland United States have been deforested unnecessarily, and the floods and low waters ascribed to this cause have in some localities occasioned losses commensurate with the value of the timber. Means should be devised and applied for coordinating forestry, farming, mining, and related industries with the uses of streams for commerce and for other purposes.

Irrigation.—The storage of flood waters combined with the diversion of streams to arid and semi-arid lands for purposes of reclamation by irrigation creates canals and also tends to clarify the waters and increase the seepage or return waters during times of drought. There have already been put under irrigation over 10,000,000 acres of fertile land, adding a quarter of a million homes and several hundred million dollars of taxable wealth; and it is estimated that by fully conserving the waters and by utilizing the water-power developed in connection with storage and other works, fully three times as much land can be reclaimed in the western half of the United States.

Water-Power.—Locks and certain other works designed to improve navigation commonly produce head and store water in such manner as to develop power available for industrial purposes, while works designed to develop power on navigable and source streams affect the navigation and other uses of river systems; and these uses must necessarily be considered together. The facts ascertained in certain specific cases furnish a basis for the claim that the value of the power would pay the cost of all engineering and other works required in such cases to control the streams for navigation and other uses. In the light of recent progress in electrical application, it is clear that over wide areas the appropriation of water-power offers an unequalled opportunity for monopolistic control of industries. Wherever water is now or will hereafter become the chief source of power, the monopolization of electricity produced from running streams involves monopoly of power for the transportation of freight and passengers, for manufacturing, and for supplying light, heat, and other domestic, agricultural, and municipal necessities, to such an extent that unless regulated it will entail monopolistic control of the daily life of our people in an unprecedented degree. There is here presented an urgent need for prompt and vigorous action by State and Federal Governments.

Land Drainage Reclamation.—Any comprehensive system of improvement of inland waterways will necessarily affect the drainage or reclamation of swamp and overflow lands, which are mainly rich alluvial tracts largely along or near waterways. The construction of dikes and levees or bank-protective works and the deepening of channels are often closely connected with means of control both of overflow and of underflow by drainage. It is estimated that there are 77,000,000 acres of such land, now unproductive, but which with drainage and protection from overflow will have an exceptionally high agricultural value; if divided into 40-acre farms these lands will furnish homes for some 10,000,000 people.

Coordination.—The control of waterways on which successful navigation depends is so intimately connected with the prevention of floods and low waters, and works designed for these purposes; with the protection and reclamation of overflow lands, and works designed therefor; with the safeguarding of banks and maintenance of channels, and works employed therein; with the purification and clarification of water-supply, and works designed therefor in conjunction with interstate commerce; with control and utilization of power developed in connection with works for the improvement of navigation; with the standardizing of methods and facilities and the coordinating of waterway and railway instrumentalities; and throughout the larger area of the country with reclamation by irrigation and drainage, and works designed primarily for these purposes,—that local and special questions concerning the control of waterways should be treated as a general question of national extent, while local or special projects should be considered as parts of a comprehensive policy of waterway control in the interests of all the people.

Governmental agencies whose work is related to the use and control of streams are now in existence in the Federal Departments of War, Interior, Agriculture and Commerce and Labor; and it is desirable in order to prevent duplication of work and function and to avoid unnecessary delays in the development of the inland waterways that means should be provided for coordinating all such agencies.

In a comprehensive system of waterway improvement and control designed to meet present and future needs, the practicability of any project will depend not alone on local and general demands of commerce, but measurably on attendant natural and industrial conditions, including nature of banks and bed, suitability of the ground as a foundation for works, volume of water and liability to floods and low stages, configuration of the watershed and its susceptibility to control by judicious agriculture and forestry or by reservoirs and other means, local and general demand for pure water-supply, amount and value of available water-power incident to the works, proximity and cost of structural materials, relations to existing and prospective projects on the same and neighboring waterways, and all other physical and economic factors entering into or tending to counterbalance the cost; and the local surveys or plans for any project should take account of all such natural and industrial conditions and be adapted to the attainment of maximum benefits at the minimum cost.

Surveys—Physical Data.—Existing data concerning the volume, regimen, and other physical features of most streams are meager and imperfect. Since plans for improving and controlling the waterways and utilizing the waters must rest on these facts, it is desirable that means be employed to extend and perfect physical data relating to the navigable and source streams of the country.

Administration.—In order to improve the inland waterways for navigation and at the same time coordinate the agencies and means of transportation, develop the collateral benefits of waterway improvement, adapt all natural and industrial conditions related with waterways to the attainment of maximum benefits at the minimum cost, and perfect means for distributing the cost equitably between Federal agencies, States, municipalities, communities, corporations, and individuals in a prompt and efficient and economical manner, it is desirable to maintain an administrative agency with large powers for the investigation and elaboration of projects under suitable legislative regulation.

Conservation of Gifts of Nature.—Our unsurpassed natural wealth and the eagerness of our people for immediate results regardless of future needs have led to a policy of extravagant consumption of national resources and to an encouragement of monopoly whereby an excessive share of such resources has been diverted to the enrichment of the few rather than preserved for the equitable benefit of the many.

Monopolistic tendencies have appeared (a) in the extensive control of mineral fuels on public lands whereby large values essential to the development of the country have passed beyond public regulation; (b) in the acquisition and needless destruction of forests, whose preservation is a public necessity for stream control, for timber supply, and for other purposes; (c) in the acquisition of controlling sites on waterways and the appropriation of valuable water-powers with their segregation from public use without adequate compensation, whereby indispensable utilities escape public regulation in the interests of the people; (d) in the segregation of lands, especially in the semi-arid regions, whereby development is retarded so that the lands remain without benefit to commerce or advantage to the growth of the country; (e) in the control of products and of transportation to disturb the normal values and natural channels of trade, thereby imposing undue burdens on producers and consumers; and (f) in various interferences with the production and commerce of the country, whereby prosperity is curtailed and progress impeded.

While such monopolistic tendencies have been conspicuous in connection with the agencies of transportation, they are now in many cases opposing the best utilization of streams by diverting their control from State and Federal jurisdiction in the public interests to personal and corporate means of excessive and burdensome profit. Since transportation is a primary factor in the existence and development of any people, and is increasingly important with the growth of population, it is essential that its means should be regulated in the public interests; and any plans for relieving congestion of transportation in the United States should be so framed as to employ all proper State, Federal, and municipal agencies in protecting from monopolistic control not only the agencies and avenues, but also the materials of interstate commerce.

RECOMMENDATIONS.

A. We recommend that hereafter plans for the improvement of navigation in inland waterways, or for any use of these waterways in connection with interstate commerce, shall take account of the purification of the waters, the development of power, the control of floods, the reclamation of lands by irrigation and drainage, and all other uses of the waters or benefits to be derived from their control.

B. We recommend that hereafter both local and general benefits to the people shall be fully considered in any such plans for the improvement of navigation in inland waterways, or for any use of these waterways in connection with interstate commerce; and that wherever practicable Federal agencies shall cooperate with States, municipalities, communities, corporations, and individuals with a view to an equitable distribution of costs and benefits.

C. We recommend that hereafter any plans for the navigation or other use of inland waterways in connection with interstate commerce shall take full account of transfer facilities and sites, and of the location of tracks, grades, bridges, dams, depots, and other works on navigable and source streams with a view to equitable cooperation between waterway and railway facilities for the promotion of commerce and the benefit of the people.

D. We recommend that any plans for improvement of the inland waterways shall take account of the present and prospective relation of rail lines to such waterways, and shall ascertain so far as may be whether such waterways when improved will be effectively used in the face of railway competition; and that the relations between railways and waterways be further examined with the purpose of devising means of rendering the two systems complementary and harmonious and making such fair division of traffic that rates and management may be coordinated economically and with benefit to the country.

E. We recommend the adoption of means for ascertaining regularly all facts related to traffic on the inland waterways, and for publishing the same in form suitable for general use.

F. We recommend the adoption of means for ascertaining and rendering available, at such rate as to meet public necessities, all requisite data related to the physical character and general utility of the navigable and source streams of the country.

G. We recommend that hereafter any plans for the use of inland waterways in connection with interstate commerce shall regard the streams of the country as an asset of the people, shall take full account of the conservation of all resources connected with running waters, and shall look to the protection of these resources from monopoly and to their administration in the interests of the people.

H. We recommend that the Congress be asked to make suitable provision for improving the inland waterways of the United States at a rate commensurate with the needs of the people as determined by competent authority; and we suggest that such provision meet these requisites, viz., expert framing of a definite policy; certainty of continuity and coordination of plan and work; expert initiative in the choice of projects and the succession of works; freedom in selection of projects in accordance with terms of cooperation; and the widest opportunity for applying modern business methods.

I. We recommend that the Congress be asked to authorize the coordination and proper development of existing public services connected with waterways; and we suggest that such enactment might provide that the President of the United States be authorized, with the advice and consent of the Senate, to appoint and organize a National Waterways Commission to bring into coordination the Corps of Engineers of the Army, the Bureau of Soils, the Forest Service, the Bureau of Corporations, the Reclamation Service, and other branches of the public service in so far as their work relates to inland waterways, and that he be authorized to make such details and require such duties from these branches of the public service in connection with navigable and source streams as are not inconsistent with law; the said Commission to continue the investigation of all questions relating to the development and improvement and utilization of the inland waterways of the country and the conservation of its natural resources related thereto, and to consider and coordinate therewith all matters of irrigation, swamp and overflow land reclamation, clarification and purification of streams, prevention of soil-waste, utilization of water-power, preservation and extension of forests, regulation of flow and control of floods, transfer facilities and sites and the regulation and control thereof, and the relations between waterways and railways; and that the Commission be empowered to frame and recommend plans for developing the waterways and utilizing the waters, and as authorized by Congress to carry out the same, through established agencies when such are available, in cooperation with States, municipalities, communities, corporations, and individuals, in such manner as to secure an equitable distribution of costs and benefits.

INQUIRIES IN PROGRESS.

At the fifteenth session of the Commission (May 21) it was decided to propose a Conference on the Conservation of Resources, to be held in Washington early in 1908, and a special committee was appointed to present the matter to the President of the United States. At the twenty-third session (October 3), at which the President presided, it was decided to call such a Conference.

On Nov. 13 the President issued invitations to the Governors of the States and Territories to meet at the White House May 13-15, 1908, the Conferees to comprise also three assistants or advisors to be selected by each Governor; the Senators and Representatives in the Sixtieth Congress; the members of the Inland Waterways Commission, and representatives of certain national organizations dealing with natural resources. The Commission anticipates from the deliberations of this Conference results of the utmost value as regards both conditions and policies.

The time and means at the disposal of the Commission

have been wholly insufficient to frame a comprehensive plan extending in detail to all the waterways of the country. The task is large, and is affected by projects for improving waterways and opening canals for navigation and other purposes which are now advocated by numerous associations of citizens in various parts of the United States. In all these systems—indeed in every State and Territory—the respective obligations of the State and Federal Governments to the people and the relations of vested interests are of such complexity as to demand prolonged consideration not only by the Commission but by State and Federal officials; and it would seem premature to outline a general plan necessarily affecting so many and so varied obligations and interests pending the Conference on Conservation, at which it may be anticipated that the interests of all the people will be fully represented.

The suggestion that "the reports of the Commission shall include both a general statement of the problem and recommendations as to the manner and means of attacking it" has received consideration, and has led to the foregoing Findings and Recommendations. The Commission is, however, fully aware of the incompleteness of this report, and is desirous of continuing investigation and discussion with a view to further action.

Respectfully submitted,

Theodore E. Burton, Chairman; Francis G Newlands, Wm. Warner, J. H. Bankhead, W. J. McGee, F. H. Newell, Gifford Pinchot, Herbert Knox Smith.

SUPPLEMENTARY REPORT OF GEN. ALEXANDER MACKENZIE, COMMISSIONER.

1. As a member of the Inland Waterways Commission, I am in accord with the general principles enunciated as proper for consideration in connection with the preparation of plans for improvement and control of inland waterways; and with recommendations which advise suitable provision for continuing the improvement of inland waterways at a rate commensurate with the requirements of commerce; and, so far as justifiable, with cooperation between Federal agencies and States, municipalities, and communities with a view to a distribution of costs and benefits; and I am in accord with a suggestion that in the carrying out of examinations and surveys and in the making of plans of improvement of inland waterways, such consideration be given by the War Department to the subject of water power, floods and low water, drainage, and such other related subjects as may have a bearing upon the improvement of navigation, and such as Congress, in its wisdom, may provide for.

2. I am in the fullest accord with recommendations looking to the protection to the greatest extent of the natural resources of the country, both in their relation to the interests of navigation, and in the interest of multiplying prosperous homes; and I am in accord with the thought of utilizing such resources in every legal and proper way with a view to recompensing the Government for expenditures made in carrying out improvements.

3. I am not fully in accord, however, with the thought that all the related subjects mentioned, important and worthy of consideration by the Government as they may be, are as clearly and necessarily associated with the subject of channel improvement and interstate commerce as is assumed in the report, or that such assumptions can properly be made in all cases without further investigation, including possibly some legal questions.

4. I am in accord with the desire of this Commission to continue its investigations and discussions with a view to further consideration of interior waterway improvements after consultation with transportation experts, and a more detailed consideration of the conservation of natural resources and coordination between the General Government and States after the conference on conservation to be held in May.

5. I can not, however, agree with the recommendation for the establishment at this time of a permanent inland waterways commission, vested with the authority indicated, in addition to or as a substitute for the existing Commission. Until this Commission shall have fully carried out the duties allotted to it, and prepared a comprehensive plan for the improvement and control of the river systems of the United States, or at least until such work is more advanced and results more thoroughly considered, I believe a recommendation for so radical a departure in the methods of planning and executing the improvement of waterways as that proposed is at least premature.

6. Moreover, it is my belief that further investigation will demonstrate that when this Commission shall have completed its labors, all necessary cooperation can be secured, and all work proposed for the permanent commission can be equally well provided for by the existing agencies of the Government, and that through such agencies, without the interposition of a permanent commission, improvement of waterways and attention to allied subjects will be more promptly accomplished. While fully appreciating the importance of having general principles and schemes considered and recommended by a commission as is now being done, and as will continue to be done, I have grave fear that the scheme of operations recommended in connection with the proposed permanent commission would be found to be impracticable.

A. Mackenzie,
Brig. Gen. Ch'f of Eng'rs.

SUPPLEMENTARY REPORT OF SENATOR FRANCIS G. NEWLANDS, COMMISSIONER.

I concur in the report of the Commission, but desire to emphasize my belief that it is of the highest importance that in dealing with subjects relating to the respective powers, rights, and interests of the Nation, States, municipalities, corporations, and individuals, large powers and a comparatively free hand should be given to an administrative body of experts in the full development of projects, lest the complexity of the transactions, the time necessary to secure Congressional approval, and difference of view as to purpose or method, may result in indecision and delay, the worst enemies of effective development.

An ample fund should be provided, to be reinforced from time to time either by legislative appropriation or by bond issue, and the administrative board or commission should be given the power, not only to investigate projects, but also, when determined to be feasible, to enter, with the approval of the President, upon their immediate execution; but the power should be limited so as to prevent such administrative body from entering into any contract unless there are sufficient unappropriated moneys in the fund to meet the cost thereof.

Unless some method of construction and development, insuring prompt decision and execution and continuous and consecutive work by a body of experts is adopted, I fear that the best of projects may be wrecked in the shoals and quicksands of legislation.

Francis G. Newlands.

THE DEVELOPMENT OF THE MECHANICAL FILTER PLANT.

Armed with authority and provided with money by a recent act of the Ohio Legislature, the Ohio State Board of Health has recently been conducting an investigation of water and sewage purification plants in operation within the State. A portion of this work has been carried on by Mr. Philip Burgess, Assoc. M. Am. Soc. C. E., Special Assistant Engineer to the Ohio State Board of Health. At a meeting of the Ohio Engineering Society at Columbus on Feb. 12, 1908, Mr. Burgess presented an interesting paper on "The Development of the Mechanical Filter Plant." The opening portion of the paper briefly reviewed the history of mechanical filtration, calling attention to the improvements in mechanical filters due to changes in design and materials of construction and to the use of various automatic devices for operation. He then proceeded to take up the various essential elements of the mechanical filter in some detail. These elements are the tank, the strainer system, the arrangement for washing the dirty sand, and the filtering material itself. The main part of the paper is given in full:

FILTER BOX OR TANK.—The early filter tanks were constructed of wood and were round. Their shape was determined somewhat by economy of construction, but principally from the fact that revolving rakes were used to agitate the sand during washing. With the introduction of air agitation, which followed in about 1900, it was possible to use tanks of rectangular shape, which required less floor space and also permitted a better arrangement of the collecting system.

With the change in agitation came also a gradual increase in size from an average area of 177 sq. ft., corresponding to a 500,000-gal. unit, to large rectangular tanks, 1,400 sq. ft. in area, and of 4,000,000 gals. capacity, such as are used at Cincinnati. The construction of such large tanks has been made possible and economical by the recent development in the art of reinforced-concrete construction.

The proper size of the filter units is governed largely by the total capacity of the plant. Until comparatively recently it was common practice to build them in 1,000,000-gal. units, but in the large plants of recent construction the capacity of the units has been increased to 3,000,000 and 4,000,000 gals. The Columbus filtration plant comprises ten 3,000,000-gal. units, while that at Cincinnati is composed of 28 of 4,000,000 gals. In general it may be said that the larger the filter units, the greater the storage of water required between the filters and the high-service pumps in order to maintain the supply during such times as some of the filters are idle for washing or other reasons. There is considerable economy in construction and also greater ease of operation with large units, and hence their use in plants of large capacity.

STRAINER SYSTEM.—After the size of the tanks has been determined the next feature to consider in the arrangement of a filter is the strainer system, the details of which offer, perhaps, more chance for originality on the part of the designer than any other one feature. The purpose of the system is two-fold—to serve as a collector of the filtered water, and also as a distributor of the wash water—and in proportion as the latter qualification is met is largely determined the success or failure of the filters.

The first form of strainer system, as previously stated, comprised a brass wire screen or perforated plate supported on a false bottom. These screens soon proved unsatisfactory, as they were easily broken or clogged, and from the large area of the openings provided did not give a good distribution of the wash water. The use of the filters soon developed the fact that it is necessary to have a controlling loss of head in the strainer system which shall offer such a large resistance in proportion to the total resistance offered to the inflow of wash water, that any unequal friction in the sand above the strainers has little effect on the distribution of the wash water. This requires a reduction in the total area of openings in the strainer system, and the screens were soon replaced by a grid of small pipes into which perforated brass strainers were tapped at frequent intervals. At Harrisburg, Pa., a very satisfactory strainer system is in use and the necessity for the perforated strainers has been avoided by placing the perforations in the bottom of the lateral pipes instead of in the top as was first considered necessary.

In order to make the construction as durable as possible, it was common practice to use brass pipes for the laterals, and as this was expensive the strainer system sometimes cost over $2 per sq. ft. of filter area. It was largely to reduce this cost that the use of concrete channels covered by brass plates was next tried. This method has been found not only to decrease the cost of construction, but also to provide the additional advantage that the plates are easily removed in case of obstruction by growths or any other cause.

The strainer system at Cincinnati is a good illustration of this type of construction. The filter bottom contains concrete channels, 1 ft. c. to c., and the area of these channels is approximately 8 sq. ins. They are covered with removable brass plates, which contain perforations with an aggregate area such that the loss of head at the strainers during washing is very nearly 5 ft. This large loss of head insures a good distribution of the wash water, no matter what the condition of the sand in the filter.

Another advantage in the use of concrete is that it offers a means of constructing the bottom of the filter in such a shape as to avoid dead spaces between the points of application of the wash water where growths of bacteria might accumulate. This is accomplished at Cincinnati by separating the strainer plates by concrete ridges.

ARRANGEMENT OF WASH WATER TROUGHS.—Having described the methods of applying the wash water, it is next necessary to consider the means provided to remove the dirty water from above the sand. With the early wooden tubs of the New York and Jewell types, this is accomplished by allowing it to flow over the top of the filters into an annular space provided between the filter proper and the settling tank, the sides of which are extended above the top of the filter tank. In the Warren filter, annular metallic troughs are provided around the inside of the filter tank and the wash water overflows into these troughs and is removed by connections to a drain. These methods of removing the wash water are fairly satisfactory, although the center of the filter does not wash so rapidly as the sides, as there is less agitation at the center from the fact that the lineal velocity of the revolving rakes is less; moreover, the horizontal distance that the wash water has to travel is greatest at the center. With the use of rectangular concrete tanks it is possible to provide a more efficient system of gutters.

Practice has developed the fact that the proper washing of the filter is of the greatest importance in obtaining efficient results, and that in order to obtain a proper distribution of the wash water it is necessary that the troughs be of sufficient size and not too far apart. If the troughs are too small they are flooded in the back portion of the filter farthest removed from the drain, and if placed too far apart the wash water from that portion of the filter farthest from the gutter has to travel too great a distance horizontally, allowing a deposition of some of the suspended solids. The maximum horizontal distance traveled by the wash water should not be greater than 3½ ft. and the troughs should not be more than 7 ft. apart.

One of the chief causes of the many failures of the gutters provided in mechanical filters to remove the wash water is the fact that in figuring their capacity engineers neglect to provide sufficient gravity head to allow the water flowing into the gutters to obtain an initial velocity, and only sufficient head is provided to

keep the water in motion in the troughs after it has acquired an initial velocity. The velocity head is the ruling factor in the design of gutters, and economy of section requires as deep a gutter as possible.

This principle was considered in the design of the gutters in the Cincinnati filters. Each of these gutters is 14 ins. wide, with a maximum depth of 21 ins. They are 14 ft. long and will each carry about 4.2 cu. ft. per sec. at a maximum velocity of not far from 4 ft. per sec. With the shallow gutters frequently provided in filters the maximum velocity is generally not greater than 2 ft. per sec.

AGITATION.—There have been several changes in the methods of agitation applied to assist in washing filters. Mechanical rakes were first used, and in general have proved satisfactory for small tanks. With the larger rectangular tanks air under a pressure of about 5 lbs. per sq. in. is sometimes applied, and proves satisfactory when properly handled. It is introduced either in a separate system of small perforated pipes or into the strainer system direct. Either arrangement accomplishes practically the same result, although the second requires a less first cost.

In the preliminary experiments at Cincinnati it was learned that air agitation was unnecessary and that the best results were obtained by applying the wash water at higher rates than those in common use, namely 8 to 12 ins. per min. The Cincinnati plant is designed to permit of an application of the wash water at a rate of 30 ins. rise per min. and no other agitation is provided. The rate actually used at Cincinnati is about 25 ins. per min., and the sand in the filter is lifted 24 ins. during washing and is so thoroughly scoured by the water that but 2 min. application is required to wash the filter. With the slower rates of application and mechanical agitation the length of time required to wash a filter varies from 8 to 20 min., depending on the preparation of the water for filtration, and the quantity filtered between washings.

FILTERING MATERIAL.—Just as there has developed a greater appreciation of the necessity for an economical and efficient washing system, so has there developed a feeling that the actual size of the filtering material used is not as important as was at first thought. The sand first used was of a coarse grade and as nearly uniform size as possible, and cost perhaps $5 per ton. Modern practice permits the use of ordinary river sand, washed and screened, of somewhat less uniform size and costing perhaps $2 per ton. If the material actually provided proves to be too fine it is possible by a judicious use of wash water and an occasional scraping to increase its size, and, if too coarse, more fine material is easily added. It is found that too great a proportion of fine material gives too large an initial loss of head, while if the material is too coarse the effluent from the filter immediately after washing is unsatisfactory.

In general the specifications for filtering material are now much less rigid than they used to be, as the sand is easily graded by the wash water after placing in the filter. Modern practice now requires the use of sand having an effective size of about 0.35-mm. and a uniformity coefficient of 1.3 to 1.6.

METHODS OF CONTROL.—Before concluding the discussion of the development of the filter, brief mention will be made of the methods now in use for controlling their operation. The valves of the first filters were all hand-operated and no automatic devices were provided to maintain a constant rate of filtration nor loss of head gages to indicate when washing was necessary. For economical reasons it is desirable to maintain the rate of filtration at as nearly the maximum efficient rate as possible, and also to make the period of time between washings as long as possible.

The early automatic rate controllers are of the open type, and depend on the automatic control of a hinged valve by a float generally contained in a small open tank. These controllers are efficient but require that all the available head on the filter shall be above the controlling valve, and moreover, the loss of head in the controllers themselves is sometimes as great as 2.5 ft. In order to avoid this loss of head and to decrease the lift necessary to pump the water to the filters, closed controllers are now sometimes used and their principle of operation depends on maintaining a constand head on a fixed orifice by means of a balanced valve.

In order to maintain the longest possible period between washings, it is necessary to know just when a filter is dirty, and gages are now used to show the difference between the static head of water on the filter and in the effluent pipe. When this difference reaches the maximum head allowed the filter is washed. These gages are of use, also, as indicating the initial loss of head in the filter, and the degree to which the filtering material is cleaned.

With large plants economy of labor necessary for operation requires that some auxiliary power be provided to operate the regulating valves, and also that this power be applied from a central point of control. This is accomplished either by the use of hydraulic valves operated from a stand, or by electrically-operated valves, the motors of which are controlled from a central switchboard. The former method is in more general use, but the latter is provided at Cincinnati, where no water is available under sufficient pressure to operate hydraulic valves. The efficiency of the automatic devices provided at the Cincinnati plant may be estimated from the fact that a single attendant may easily operate the filter house, the capacity of which is 112,000,000 gals. per day.

In the above discussion it has been endeavored to indicate briefly the development that has taken place in the filters themselves, and the changes next considered will be in the preparation of the water before it is applied to the filters. This preparation includes the application of a coagulant and a storage of sufficient time to allow both a completion of the chemical reaction of the coagulant and a partial deposition of the coagulated masses.

COAGULANT.—Until 1900 the only coagulant in general use for mechanical filter plants was commercial sulphate of aluminum, commonly called "filter alum." Since 1900 copperas or sulphate of iron applied together with lime has come into favor as a coagulant, and is now in use at many filtration plants, among which may be mentioned five in Ohio. The copperas in general use is sold by the American Steel & Wire Co. and as it is a by-product for which there is but a limited demand it is sold at about one-half the price asked for alum. It is not the intention of this paper to discuss the relative merits of copperas and alum as coagulants, but a brief statement will be made of a few of the facts that have developed during the recent special investigations of water purification plants in Ohio by the State Board of Health.

The use of alum requires merely that there be sufficient alkalinity in the treated water to insure its decomposition and removal, and in order to accomplish this it is sometimes necessary to introduce also a small quantity of lime. The successful use of copperas and lime requires an accurate adjustment between the two coagulants, as the use of too little lime gives a poor coagulation, and the use of too large a quantity causes the formation of "after deposits" in the filters. Such deposits have caused considerable trouble at Marietta, Ohio, and in both the old and new filter plants at Lorain, Ohio.

It has frequently been stated that other conditions being the same, less copperas than alum is required to give the same efficiency of removal in the coagulating basins. This statement has not been borne out at Lorain, particularly in the new plant, where it has been impossible to obtain continually satisfactory results using copperas, and in a recent official test of the plant, using approximately 2 grains of copperas, the average efficiency of bacterial removal by the coagulating basins was but 39%. In a subsequent official test approximately 2.5 grains of alum were applied and the efficiency of the coagulating basins was increased to 81%. The experience at Lorain would seem to indicate that Lake Erie water is better coagulated using alum than using copperas, and that the application of alum is much more easily accomplished. At Cincinnati, the use of copperas and lime appears to be very satisfactory, and it is apparent that the best results in coagulating water are not to be obtained by an indiscriminate use of either coagulant, but by a study of the character of the water to be treated, and by proper design and arrangement of the plant.

In regard to the effect of the coagulants on the water treated, the use of alum produces a more sparkling water and the change in hardness brought about consists in converting a part of the temporary hardness into permanent hardness, while with the application of lime and copperas there is an addition of approximately 0.5-grain per gal. of total hardness for each grain per gal. of copperas applied. This latter statement is on the assumption that lime is not applied in excess.

Not only does the alum produce a more brilliant water, but it removes a much larger percentage of dissolved color, so that its use is necessary for the satisfactory treatment of a highly colored water.

In general it may be said that there appears to be but one recommendation for the use of copperas as a coagulant, and that is its less first cost, which is, however, offset by additional difficulties and expense incurred in its application. Unfortunately, comparative figures that have been published on the use of the coagulants, have been based on the first cost of the chemicals and not on the total operating expenses of the plant.

METHODS OF APPLYING COAGULANT.—As previously stated, the original method of applying the coagulant and one which is now in common use in small plants, consists in dissolving weighed charges of the chemical in storage tanks where the solution is kept until used. It is pumped or flows by gravity into the raw water, and its application is varied by changing either the strength of the solution or the rate of its application. While this method of handling the coagulant is satisfactory for small plants, at St. Louis and Cincinnati, where the quantity of coagulant used is very large, amounting to several tons a day, the room required for the storage of the solution would be very great, and at St. Louis was developed a method of direct application of the coagulants without storage. This is accomplished by introducing a constant weight of the dry chemical at stated short intervals of time into a tank, through which a constant stream of water is passed upward. In this procedure there soon develops a condition that the quantity of chemical carried away by the water is equal to that introduced, and the solution maintains very nearly a constant strength. The quantity of coagulant applied to the water is very easily varied by changing the interval of time between the application of the charges. This method of dissolving the coagulant also eliminates the necessity for pumping the solution, as it is carried by gravity to its point of application, which is generally near the entrance to the coagulating basins.

COAGULATING BASINS.—That part of the filter plant that has been least appreciated is the coagulating basin, and in the plants of early design the basins have a very limited capacity and were provided merely to give storage for the completion of the chemical reaction without any subsequent sedimentation. The removal of the suspended matters in the water is all accomplished by the filter, and when the raw water is dirty the sand rapidly clogs and it is necessary to wash the filters at frequent intervals so that the wash water used is sometimes over 30% of the quantity filtered. At such times also it is necessary to use very large quantities of coagulant.

With the use of concrete construction, the capacity of the coagulating basins has been increased from one to three hours and finally, at Harrisburg and Cincinnati, to about five hours, and they effect both coagulation and sedimentation. This large increase in the capacity of the coagulating basins causes not only a greater ease of operation, but a great improvement also in the efficiency of the results obtained.

Just as a bridge engineer would not design a structure for the average, but for the maximum load, so should a filter plant be designed for the treatment of the worst water that it is required to purify. While three hours sedimentation after coagulation is perhaps sufficient for treatment under average conditions, the frequent occurrence of periods of high turbidity in the raw water requires that a longer period of sedimentation be provided in order to secure economical and efficient results at such times. Moreover, the changes in the character of the raw water require changes in the period of coagulation and sedimentation provided. This has been accomplished at Harrisburg, Pa., by providing two basins and two possible periods of coagulation, varying from 30 min. to 5 hrs., and at Cincinnati, where three basins are provided and the time of coagulation and sedimentation may comprise any one of the following periods: 0.4-hr.; 2.1 hrs.; 2.6 hrs.; 4.3 hrs., and 4.7 hrs.

The economy of providing a secondary application of the coagulant has not been appreciated until recently. Highly turbid waters, which require large quantities of coagulant, absorb and render inactive sometimes even 75% of the total quantity of coagulant applied. This fact has been appreciated in some of the most modern plants, where it has been recognized that, if sufficient sedimentation is provided, the greater proportion of the suspended matters in the raw water may be removed either by plain sedimentation, or by sedimentation following the application of a small quantity of coagulant. This is followed by the application of a second quantity of coagulant, perhaps one hour before the water is applied to the filters.

In general it may be said that the satisfactory treatment of the water for filtration requires that its turbidity shall be reduced to not greater than 50 parts per 1,000,000, and that if sufficient sedimentation is provided this may always be accomplished by the use of a small quantity of coagulant. Flexibility in the period of sedimentation allowed and the provision of at least two points for the application of the coagulant, while requiring a greater first cost of construction, permit of much greater ease of operation and better and more economical results.

CLEAR WELL.—The last unit of the mechanical filter plant to be considered, namely the storage of filtered water between the filters and the pumps, requires but little discussion, although much of the difficulty of operating plants of early design is due to inadequate provision for storage of filtered water at the plant. The period of storage allowed is sometimes not greater than 10 min. operation of the pumps, and it is found practically impossible to maintain the filters and pumps at the same rate, and it is also sometimes necessary to run the filters very fast immediately after washing. This is particularly true when direct pumping is used without a distributing reservoir, and in such plants the storage period provided should not be less than two hours. When a plant is operated at its full capacity it is impossible to obtain satisfactory results without a sufficient storage in the clear well, even with a distributing reservoir, and the minimum working storage

allowed at any plant should not be less than one hour, and preferably at least two hours.

COST OF FILTRATION AND RESULTS OBTAINED.—While it would be desirable to include in this paper a statement of the costs of installation and operation of mechanical filter plants, there are so many features to be considered that it is impossible to include more than a few general statements.

The filter plants of early design, comprising tanks of wooden construction, cost from $3,000 to $8,000 per 1,000,000 gals. capacity, and their operation costs from $3 to $12 per 1,000,000 gals., depending on the capacity of the plant, the character of the water treated, the quantity of coagulants and fuel necessary, and the cost of labor required for operation. With concrete construction, the cost of installation is greater and averages about $13,000 to $16,000 per 1,000,000 gals. capacity. The cost of operation may be kept down to a low figure, as is well illustrated at Harrisburg, where the average cost of filtering each 1,000,000 gals. during 1906 was but $4.76, including $1.40 for coagulant. The cost of labor, $1.98 per 1,000,000 gals., will decrease in subsequent years as the quantity of water filtered approaches the ultimate capacity of the plant.

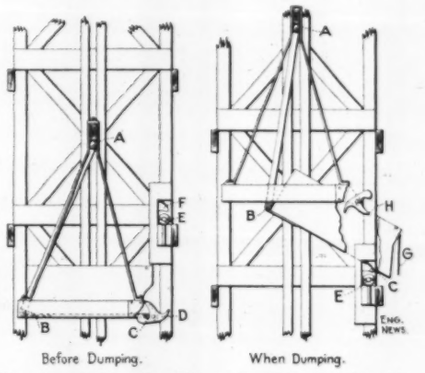
The bacterial removal that may be accomplished by a well-designed and operated mechanical filter plant is also well shown at Harrisburg, where the average bacterial removal by the plant during 1906 was 99.24% of the bacteria in the river water. This was accomplished with the use of an average quantity of but 0.95-grain per gal. of alum and but 2% of wash water.

In conclusion, it should be said that the use of the mechanical filter has long since passed the experimental stage, and that it has proven very efficient and economical for the purification of turbid waters, such as are found in the Middle West. The installation of such plants has generally been followed by an improvement in the general health of the community, and the satisfaction of having a clear, wholesome water supply has more than repaid any expense incurred by the installation and operation of the filter plant.

A HOIST FOR FEEDING MATERIAL TO THE CONCRETE MIXER.

In most concrete construction the amount of work that can be performed in a given time is primarily dependent upon the amount of concrete that can be mixed. The output of the mixer, in its turn, is measured by the dimensions of the machine and the facility with which the raw material can be brought in and the mixed concrete taken away to where it is to be deposited. In present practice the mixer has been brought to such a degree of efficiency that it can mix more material than it is economically possible to get to it, so that any delays in the concrete depositing operation usually occur between the material pile and the mixer. The number of men employed in feeding the mixer can sometimes be reduced to an economical basis by the use of a feeding hopper or by the proper placing of the machine—as, for instance, in a pit lower than the material piles, so that the mouth of the mixer is on a level with these piles—but often the conditions of the layout and the machinery prohibit such an arrangement. In order to bring this feeding of the mixer up to the same economical basis as the rest of the procedure, there have been many schemes devised and tried, such, for instance, as inclined runways, hinged hoppers and elevators similar to those almost universally used now in all building construction for the transportation of materials during erection. One of the type last noted, invented and used by Messrs. H. C. Lindsly & Son, of Kansas City, is described in this article. It was first used on a piece of work in a deep cut where no location could be found for the mixer, so it could be fed by wheelbarrows, dump cars on inclines, or by a derrick of any reasonable dimensions. In order to set the mixer convenient to the work it was placed on a tower at the elevation of the finished abutment, and the automatically discharging elevator was designed and built to feed it.

This hoist consists of a shallow steel box or pan about four feet square and only 15 ins. deep, hung in a light carrying frame by a pair of eyebars at the back, and a pair of small cam levers, or trippers, at the front, or delivery side. The pan, in its carrying frame, rests on the ground to receive a batch of aggregates, which are easily dumped into it from wheelbarrows or small dump cars. The rock, sand, and cement are dumped into the pan in alternate layers, thus making possible a gravity mixing of some value as the elevator is hoisted. The pan is automatically tripped at the proper level, moving forward seven or eight inches and then tilting up to an angle of 45°, when the materials rush from the pan through a small feed chute into the mixer. The water is turned on from a measuring tank into the chute as the materials are running through it, and thus all the constituents of the concrete are partly mixed before they enter the mixer, appreciably reducing the time they must remain there to produce a satisfactory concrete. On being lowered, the pan automatically recovers its normal position in the carrying frame and descends to the ground for the next charge.



Before Dumping. When Dumping.

Fig. 1. Automatic Dump Bucket for Handling Concrete to and from the Mixer.
(Devised by H. C. Lindsly & Son, Kansas City, Mo.)

Fig. 1, the left-hand cut, shows the pans or receptacle as carried in the hoisting frame by the two eyebars swinging from the headbar of the frame at "A" and pivoted to the back of the pan at "B." The front of the pan is supported on a trunnion bar, which is riveted to its under side near the front edge, and which rests in sockets on the end of the carrying frame at "C." At the ends of these arms are pivoted the cam levers or trippers "D." The inner ends of these levers lie under the trunnion bars at "C," and when, on being hoisted the outer ends strike on the fixed tripping rollers "E" the pan is raised from its carrying sockets at "C" and carried forward until the trunnions rest in the fixed landing sockets at "F," the pendulum-like eyebars at the back of the pan greatly assisting in this operation. The cage or hoisting frame continues to rise until the pan takes the position shown at the right of the figure, discharging its contents into the mixer or hopper through the swinging door "G" at the front of the pan. On descending, the point "H" of the cam lever strikes the top of the tripping roller, runs out under the trunnion bar, and picks it up, replacing it in its seat in the carrying frame at "C" as the cage descends, ready for the next charge.

This simple device serves every purpose of a receiving hopper as well as an elevator. Power for its operation is taken from the mixer engine, connected by a sprocket chain to any form of light hoisting drum the owner may wish to use. The hoisting drum is handled by the engineer in charge of the mixer, who does this very easily without interfering with his care of the machine.

Its great portability is shown by the fact that it can be mounted on ordinary wagon gears, with wheels large enough to permit it to travel easily over all kinds and conditions of roads. It also permits the mixer to be mounted on wagon wheels, high enough to give it the same ease of portability, for as ordinarily mounted, on small iron wheels, large mixers are very difficult to move on any but the best of paved streets.

The application of the device to the more usual concrete elevator is shown in Fig. 2, where, besides the one feeding the mixer, a second one was used to convey the concrete directly from the mixer to a hopper on top of the forms, from which it was distributed by carts in the usual manner. This elevator was operated by one man with a gasoline hoisting engine, carrying an entire batch at one lift, and its economy as compared with hoisting by derrick in dumping buckets, or by the common brick hoist in concrete carts, is readily recognized without further mention.

FIG. 2. AUTOMATIC FEEDING AND DELIVERING ELEVATOR FOR CONCRETE.

A comparison of the cost of feeding a concrete mixer by three different methods shows well to the advantage of the above described elevator. On one part of the work on a concrete viaduct a mixer with a superhopper was fed by a gang of 12 to 14 men with wheelbarrows, over an inclined runway rising 9 ft. in about 60 ft.; the output was from 7 to 8½ cu. yds. per hour, at a cost for feeding, of 31 to 34 cts. per cu. yd. On another piece of work it was found necessary to feed the mixer with an ordinary boom derrick using dumping skips. This required ten men, one being an engineer at 50 cts. per hour, as well as an extra hoisting engine; the output was 8½ to 9 cu. yds. an hour, the feeding cost being from 25 to 27 cts. per cu. yd. One plant, using the Lindsly elevator, turned out from 9 to 11 cu. yds. per hour, with seven men feeding the elevator, at a cost slightly under 14 cts. per cu. yd.; while in

another, with the same device, the conditions were such that the concrete could be taken care of as fast as made; and with a 35-ft. lift the output was about 14 cu. yds. per hour, at a cost for feeding of less than 11 cts. per cu. yd.

The same mixer was used in each of these cases, the proportions adopted being practically the same, and the batches in each case made about 16 cu. ft. of concrete in place.

We are indebted to Messrs. Lindsly & Son for the illustrations and information from which the description of their elevator was prepared.

A STUDY OF THE ECONOMIC COST OF TYPHOID FEVER IN WARDS 8 AND 11, PITTSBURG, PA.

A unique study of 194 cases of typhoid fever, in 149 Pittsburg families was made during the latter part of 1907 by the Pittsburg Survey, which is a sociological study being carried on by the magazine "Charities and Commons," of New York, by means of an appropriation from the Sage Foundation. We are indebted to Mr. Frank E. Wing, Associate Director of the Pittsburg Survey, for a copy of a report made by him on these interesting typhoid studies. We here reprint the report, with the omission of a statistical summary which, for the most part, merely repeats the figures given in the text. The text is as follows:

During the year ending June 30, 1907, there were reported to the Bureau of Health, in Wards 8 and 11 alone, 433 cases of typhoid fever. These cases occurred in 317 families. Our investigator, five months later, was able to locate but 149 of these families, the remainder having moved either to other parts of the city, or out of the state, or having been lost track of altogether by people living in the neighborhood. It is from data secured from members of these 149 families that the facts embodied in this report were secured.

There were living in these 149 families, 999 individuals, or an average of 6.7 persons per family. Of this number, 194 individuals were stricken with typhoid fever within this one-year period. Out of the 194 cases there were 11 deaths and 183 recoveries. Eighty-nine (89) or nearly half of the cases, were children, 69 being school children, and 20 being either too young to go to school, or out of school, but not working. The other half included 26 women in charge of the home, 4 women doing day's work, 14 clerks, 6 day laborers, 9 stogie makers, 4 waiters, 6 servants, 3 salesmen, 2 milliners, 2 tinners, 2 expressmen, 3 porters, 2 storekeepers, 2 plumbers, 2 drivers, 2 tailors, and one each in 16 miscellaneous employments.

Eighty-seven (87) of these 194 patients were wage earners, contributing all or part of their earnings to the family income. As a result of their sickness, these 87 wage earners lost 964 weeks, or 18.5 years of work. This is over 11 weeks per patient, and represents an actual money loss of $10,902. In addition to this, other wage earners stopped work 182 weeks to care for patients, thereby losing $1,557 in wages, making a total loss in wages of $12,459. But this is only the beginning: 53 cases were treated in the hospital either as full pay patients, half charity, or full charity cases, at a cost of $1,141 paid by patients, and $1,534 borne by charity, either public or private, making a total of $2,676, the cost of caring for hospital patients. The remaining patients cared for at home incurred home expenses, comprising doctor's and nurse's bills, drugs, ice, milk, and other expenses, aggregating $8,179. The funeral expenses of the six patients that died amounted to $1,032. Thus we have an *aggregate money loss to the community of* $24,345, as the *cost of less than one-half of the total cases of typhoid fever in two small wards of the city within a period of one year.*

When it is considered that these are but 194 cases in two small wards out of a total of 5,637 cases in the 57 wards of Greater Pittsburg (including Allegheny) during the past year and that the disease is just as prevalent in many other sections of the city as in these wards; also that typhoid fever has been almost constantly prevalent within the city limits, with practically no abatement for the past 25 *years*, it requires only a little applied mathematics to show the probable enormity of the money loss to the community through the ravages of this disease alone year after year.

But were it necessary to measure the results only on a cold cash basis, it would still be possible, in some way, to repair the damage. On further analysis of the 194 cases under consideration, it was found that 49 suffered serious physical results. Twenty-two (22) of the 49 were only temporary, but 27, or 13.9% of the total cases studied, suffered permanently serious results. Eleven died. A school girl of 10, formerly of average health, has never recovered, constantly ailing and coughing, and probably tubercular. A girl of 22, who worked on stogies, is left in a very nervous condition, not as strong as before, and consequently cannot attain her former speed. A blacksmith will probably never work at his trade with his former strength. A 16-year old girl developed tuberculosis and was left in a weakened physical condition. A tailor cannot work as long hours as before, and has been reduced $1 a week in wages. A boy of eight is very nervous, will not sit still in school, and is rapidly becoming a truant. A mother developed a case of pneumonia from over-exposure in caring for children who had the fever, and has not been well since. Because of the death of the wife in one family, the home was broken up, two children were sent to an orphan asylum, and two others to a day nursery, where the father is to pay $4 a week for their keeping until they, too, can be received into an asylum. In one case, a stogie maker, by reason of eight weeks' sickness from typhoid, lost his job; not being able to secure other work here he became despondent, and finally deserted his family. The family of a widow and five children was thrown entirely on charity for all of their expenses for three months, because every member except a 10-year-old school boy had the disease. In one case where the mother died, the children were left alone with a careless father, who did not care for them properly. They developed scabies, and had to be sent to the municipal hospital for two weeks, and later to a fresh air home. In another instance, a mother with nursing baby contracted the fever, and the child died as a result of being deprived of the mother's milk.

So the story goes—real, very real, to the lives of the many who are so intimately concerned. Money losses can be replaced, but this includes no estimate on the value of human lives lost. It is impossible to compute, in terms of dollars and cents, what it means to a family to have the father's health so broken that he cannot work at his old job, but has to accept easier work at less pay.

It is impossible to put in tabulated form the total value to a family of a mother's health, and strike a proper balance when typhoid has left her a physical or nervous wreck. This includes no estimate as to what is the cost to a boy or girl who is obliged to leave school in order to help support the family, because typhoid has incapacitated the natural bread-winners.

Such facts as these cannot fail to show the immense drain that typhoid has been and is on the vital force of the community.

The statistics appended to the report, and not already given, may be summarized as follows: Of the 149 families, 71 took milk from grocery stores, 15 from milk wagons, 24 from cows in their neighborhood, 32 from milk depots and 7 from three other sources. The average number of persons per living room in the houses occupied by the 149 families was 4.4 and the average number of sleepers per room was 3.9. Eighty-one (81) families lived in houses which had modern water closets, in good repair, connected with the sewers, and 8 in houses having modern closets, but out of repair. The remainder, or 55 families, made use of privy vaults (17) or cesspools (38).

In a letter to Mr. Geo. W. Guthrie, Mayor of Pittsburg, dated Jan. 12, 1908, Mr. Wing stated that there was typhoid fever in one of the households from which a neighborhood milk supply was being delivered from six cows. By way of comment on the neighborhood [and grocery] milk supplies and the open privy vaults, etc., Mr. Wing, in his letter to Mayor Guthrie, said:

These facts by themselves may not be conclusive, but they suggest the importance of a thorough investigation of primary and secondary causes of typhoid in Pittsburg, which could be eradicated at the same time that the new filtration plant cleans up the water supply. In Washington, the administration has been put on the defensive because the opening of the new filtration plant has not brought down the typhoid rate as anticipated. In Pittsburg, there is opportunity for a running start which will set a standard for thoroughness in a municipal attack upon the typhoid problem. It is not anticipated that these further sources of contagion would involve much expenditure, but rather administrative forehandedness in removing them on the basis of facts gathered.

As early as last September, an ordinance, providing for an appropriation of $10,000 for a staff of sanitary inspectors to make investigations on current typhoid cases, was before the common councils of Pittsburg as an administration measure. It was dropped in the merging of the two cities. This report is brought to your attention at this time in the hope that it will be of service to you in determining the wisdom of putting a similar ordinance before the present councils. The cost of such a thoroughgoing canvass of typhoid cases covering the entire city would, as you see, be insignificant compared with the indirect tax of present conditions upon one small section of the city.

An ordinance providing for a special typhoid survey of the whole city was subsequently brought before councils, but it was considered necessary, in view of other financial and sanitary needs of the city, to let it drop.

Since the article was put in type we have received from Mr. Wing a revised and extended report of the typhoid survey already noted. Wards 25, 26 and 27 on the South side, occupied by steel workers, and Ward 21, the Homewood district, occupied by people of the "middle class," are included in the later figures. There were 929 typhoid cases, in 844 families, in the six wards, but when the study was made only 338 of the families, numbering 2,045 individuals, could be found. In these 338 families there were, during the year ending June 30, 1907, 448 cases of typhoid, with 26 deaths. Nearly half the cases (or 202) were children, of whom 164 were in school. On the same general basis as was followed for Wards 8 and 11, the aggregate actual money loss caused by the 448 typhoid cases investigated was $57,253, or about $130 per case. It will be noted that these figures make no allowance whatever for the economic loss to the community caused by the 26 deaths. We may add, that on the same basis of average cost, the 5,637 cases of typhoid fever in Pittsburg (including Allegheny) during the year involved was about $725,000.

COSTS ON A REINFORCED-CONCRETE FACTORY BUILDING.

In the December, 1907, number of "Applied Science," the official journal of the University of Toronto Engineering Society, Mr. D. L. C. Raymond gives a list of unit and total costs of a reinforced-concrete factory building recently erected in Walkerville, Ont., which, with due allowance for differences in costs of material, may be of value for comparison with American construction. The factory is a 100 × 100 ft. two-story building, with 18 ft. clearance in the first floor and 12 ft. in the second. It is of the ordinary skeleton type construction, with 16 × 16 ft. floor panels and 6-in. curtain walls. Loose rod reinforcement was used throughout with wire mesh in the slabs. The column and beam forms consisted of 2-in. Norway pine, dressed on all four sides, held together with iron clamps and supported by 4 × 4 in. cedar posts. The floor centering was 1-in. Norway pine, dressed on one side, and laid on 2 × 4 in. pieces, spaced 18 ins. on centers. A 1:2:4 mixture of rough finished concrete was used, with a 1:2 sand mortar finish for the floors.

The labor was all new to this class of work, but the daily wage is not given in the original article. Operations were commenced Sept. 3, and the building finished Dec. 1.

Below is given the itemized cost of the entire building, in which 847 cu. yds. of reinforced-concrete was employed:

	Total cost.	Cost per cu. yd.
Materials:		
Cement at $2.05 per bbl.	$3,314.08	$3.91
Sand and gravel at $1.25 per cu. yd.	1,053.85	1.25
Reinforcement at $55 per ton	2,314.08	2.73
Centering, 4 × 4-in cedar, $25 per M.		
2 × 4-in. N. pine, 27 per M.		
1-in. flooring, 28 per M.	4,943.70	5.84
Nails, etc.	106.84	.13
Labor:		
Building runs, hoisting and mixing concrete	872.00	1.03
Placing and tamping concrete	562.00	.66
Placing reinforcement	221.00	.26
Stripping, centering and cleaning up.	379.93	.45
Carpenters building and setting forms	2,069.55	2.58
Superintendence	714.00	.84
Tools and depreciation in equipment.	338.00	.40
847 cu. yds. cost	$16,829.03	$19.88

HUGE SWITCHING LOCOMOTIVES of the 0-10-0 class have been built by the American Locomotive Co. for pushing trains up the inclines in a gravity classification yard of the Cleveland, Cincinnati, Chicago & St. Louis Ry. The engines are 42 ft. 7 ins. long over bumpers (exclusive of the tenders) and have the entire weight of 137 tons carried by five axles on a wheelbase of 19 ft. Owing to the heavy service the large cylinders and the very limited cut-off, enormous boiler capacity is required. The piston valves are operated by the Walschaert valve gear. The driving springs are very short, and are placed (inverted) under the top rail of the frame, having their ends attached by links to the ends of yokes or equalizers resting on the axle boxes. The leading dimensions are as follows:

Driving wheels	4 ft. 4 ins.
Wheelbase	19 ft. 0 ins.
Wheelbase of engine and tender	56 ft. 8 ins.
Weight of engine	274,000 lbs.
Weight of engine and tender	424,000 lbs.
Cylinders	24 × 28 ins.
Boiler, diameter at first ring	6 ft. 8 ins.
Firebox	6 ft. 3 ins. × 9 ft.
Tubes: No. 446; diam. 2 ins.; length	19 ft.
Heating surface: Tubes	4,413 sq. ft.
Firebox	188 sq. ft.
Total	4,601 sq. ft.
Grate area	56 sq. ft.
Water in tender	7,500 gals.
Coal in tender	12 tons

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The unique typhoid fever survey of a portion of Pittsburg, Pa., outlined elsewhere in this issue, might well serve as an example for similar studies elsewhere. At the same time it illustrates the advantages flowing from such special research funds as the Sage Foundation, which supplied money to conduct the investigation noted and also other studies at Pittsburg conducted under the general name of the Pittsburg Survey.

It has been very properly urged upon the city councils of Pittsburg that they provide $10,000 and authorize the employment of six sanitary inspectors to make a careful typhoid survey of the whole city. It is highly desirable that such a study be made in advance of the opening of the new water filtration plant now nearing completion in order to determine and suppress typhoid which arises from other sources than the public water supply. If such cases could be got under control the advent of pure water in Pittsburg would see a still greater reduction from typhoid fever than is to be expected to result from the purer water alone. Incidentally, there would be averted suspicions of the efficacy of the filtration plant, such as have unfortunately occurred since the new slow sand filters were put in use at Washington, as noted in our issue of Feb. 16, 1908, and earlier. Permanent typhoid detective bureaus, such as we have advocated for Washington, will be necessary in many American cities before the disease is reduced to its lowest possible proportions. Necessary as pure water is in the anti-typhoid campaign, infection from milk, from a combination of open privies and swarms of predatory flies, and from contact (carelessly nursed cases) cannot be neglected if our American cities are to reduce typhoid to the level now for many years attained in the most sanitary cities of Europe.

Information received since the foregoing paragraphs were written indicates that a typhoid survey at public expense will not be feasible at Pittsburg this year, although somewhat related work may be done. If Pittsburg cannot establish a permanent typhoid detective bureau at once, it is to be hoped that the work so ably begun at private expense may be continued by the same or a similar agency until the whole city has been covered at least once. It would be a pity if the high typhoid fever in Pittsburg could not be distributed by causes with a fair degree of probability before the filtration plant goes into operation.

The promoters of the scheme to build a deep waterway parallel to the Atlantic Ocean have secured an unofficial estimate of the cost of part of the work from Gen. Mackenzie, Chief of Engineers.

As our readers will recall, the scheme is to connect by canals the existing sounds and bays along the Atlantic Coast, so that vessels could pass from Boston to Florida without going into the open ocean. About the only use of such a waterway, that we have been able to discover, would be for the passage of house-boats and other pleasure craft used on protected waters. The business of freight transportation, as every engineer knows, is done more cheaply on the ocean than on any contracted inland waterway.

However, two links in the proposed route, the Cape Cod ship canal and the ship canal between Chesapeake and Delaware bays are probably well worth constructing. In fact the former is already under way as a private enterprise. The cost of the Cape Cod Canal is estimated at $10,000,000, in round figures, and the Government surveys of the Chesapeake-Delaware waterway a dozen years or so ago fixed the cost of that also at about $10,000,000.

The Cape Cod Canal, however, would hardly meet the ideas of the inland waterway promoters, as vessels would pass into the ocean at each end, so Gen. Mackenzie submits the estimate of the Massachusetts Board of Harbor and Land Commissioners, for a 25-ft. ship canal from Boston Bay to Fall River at the head of Narragansett Bay, amounting to $57,618,000. Even with this waterway, vessels would still have to navigate 40 miles of open ocean, from the mouth of Narragansett Bay to the entrance of Long Island Sound, and it is difficult to see how an inland waterway could be made along this section except at such vast expense as to make it wholly out of the question.

Long Island Sound and the East River to the head of Staten Island already have 25 ft. depth for navigation; but in order to pass thence inland to Philadelphia with a depth of 25 ft. the Arthur Kill, back of Staten Island, and the Delaware and Raritan rivers must be deepened and a 44-mile ship canal must be built across New Jersey to connect the two latter streams. Gen. Mackenzie says that no data are available for estimating even approximately the cost of such a waterway.

For the southern portion of the proposed waterway, an estimate of $10,000,000 is made for a 16-ft. channel from Norfolk south to Beaufort Inlet, an air line distance of about 150 miles. In this way a total of $77,000,000 is reached as the cost of three links only in the projected inland waterway, while $20,000,000 would be sufficient to construct the only two links of this waterway which would be of sufficient benefit to commerce to justify construction.

We can make no better comment on the inland waterway scheme than the following quotation from President Roosevelt's message of Feb. 26:

> We must make sure that projects are not undertaken except for sound business reasons. The decision to undertake any project should rest on actual need, ascertained by investigation and judgment of experts, and on its relation to great river systems or to the general plan and never on mere clamor.

The newspapers last week reported the discovery of a conspiracy between an inventor, a patent attorney and an Assistant Examiner in the U. S. Patent Office by which the inventor was enabled to add to his application elements revealed in pending applications of a score of other rival inventors working in the same field, that of high efficiency filaments for electric lamps. In an official statement by the Commissioner of Patents, it is stated that this is the first time since the establishment of the Patent Office that an Examiner has been shown to be false to his trust. The Commissioner continues as follows:

> This favorable showing of the United States Patent Office is accounted for largely by reason of the fact that the 300-odd members of the examining corps are all college graduates and nearly all have been graduated in general and patent law, and this body of scientific men has been considered not only in this country, but in all countries having a patent system, to be the equal, if not the superior, of any like corps of men in existence. It has been impossible from 1902 down to the present date for the civil service commission to furnish the patent office with a sufficient number of technically educated men such are necessary to examine and pass upon inventions in all the known arts.
>
> Although Mr. Barton [the Assistant Examiner indicted] took the civil service examination for his position as examiner in the patent office, he failed to pass. However, he was rerated and accepted by the patent office at the minimum standard, owing to the great need of technically trained men in the office by reason of the great number of resignations of examiners occurring yearly who go out and into the employ of large corporations and established law firms at double, and oftentimes treble, the salary they receive as examiners.
>
> The patent office has been for years unsuccessfully trying to compete with large moneyed corporations for the services of technically educated men, and has been forced to accept, of late years especially, men of a less desirable class, who have been appointed whenever men could be found who possessed even a fair technical education and were willing, by reason of being out of employment, to accept temporary positions as examiners in the patent office.
>
> The Assistant Examiner, who has been thus indicted, was thirty years of age, a married man, a graduate of the College of the City of New York, and schooled in general law and in patent law; and he received a salary of $1,400 per annum.
>
> The fact that the salaries paid to patent office examiners are absurdly low has often been commented upon. While this is of course no excuse for the criminal act, the situation revealed in the Patent Office ought to receive attention. Placing the examiners' salaries at a proper rate would not only reduce the temptation these men are under, but would enable the retention of good men in the service and thus raise the grade of work. Incompetence in the Patent Office is only less serious than dishonesty, and the revenue from patent fees is sufficient to pay good salaries to the entire examining force.

The report of the Canadian Commission of Engineers on the Quebec bridge disaster was delivered to the Minister of Railways at Ottawa last week; but its contents will not be made public until the report is transmitted to Parliament. Nevertheless, several statements as to the Commission's findings appeared in American journals last week. From one of these alleged "summaries" of the report, published in a technical contemporary, we extract the following choice gem:

> The Commissioners express the opinion that the general details of construction were worked out with the greatest care and thoroughness, but that in proceeding on the general formulas now adopted as standards in bridge construction, the designers seem to have lost sight of one great basic point, the making of proper provision for maximum strain upon the great central span across the river.

This is pretty rough on the designers of the Quebec bridge. They have been accused of many things, but to insinuate that they forgot all about the 3,000-ft. central span in computing the stresses is the unkindest cut of all.

The report continues:

> The construction details were worked out with the greatest care according to the best principles of modern bridge building, but the weight of the great middle span was too great for the supporting members, hence the collapse.

Here is truth boiled down and put in a nut shell! No one who knows the members of the Canadian Commission will believe for an instant that after spending six months investigating this great disaster they have found out nothing more important than the fact that the bridge fell down because it was not strong enough to stand up!

REPORT OF THE INLAND WATERWAYS COMMISSION.

The report of the Inland Waterways Commission, with the message of the President that accompanies it, is a document of far reaching importance and one that deserves the close attention of the engineering profession. As we pointed out last week, the Commission is largely made up of engineers and its conclusions and recommendations deal largely with engineering works.

There may be some disappointment that the Commission does not in this preliminary report outline even a tentative plan of waterway improvement. Many have expected that the Commission would recommend what waterways should be improved and decide what capacity of channel should be fixed.

The Commission has not yet attempted this, however, and it is very doubtful whether it can perform this task under its present organization. It must be remembered that the Commission is not authorized by law; consequently no funds are available for its use and its recommendations have no greater legal authority than those of any body of private citizens. Its members are all busy men, carrying heavy responsibilities in other departments of government work. The very first essential to the preparation of an intelligent plan for inland waterway improvement is that careful surveys and investigations be made, or at least that existing data be carefully collected and sifted. This requires the highest class of expert work, and the Commission have no funds to employ such experts. The Commissioners themselves cannot give the necessary time from their other engrossing duties. What they have already done has been as a part of their service as public officers of other departments.

We believe, therefore, that the Commission is well justified in its recommendation that a National Waterways Commission be created by Congress, clothed with the necessary authority to make investigations and to frame and recommend plans for waterway development.

It is noteworthy that Gen. Mackenzie, Chief of Engineers, dissents, in a minority report from this recommendation, and holds that the present unofficial Commission should continue its work and prepare plans for waterway development as originally contemplated. He argues that "existing agencies" can carry on equally well the work proposed for this Commission.

Many will interpret the Commission's report as an initial step toward placing the work of waterway improvement under the control of civilian engineers, and will read in Gen. Mackenzie's minority report a protest against displacement of the Corps of Engineers.

To what extent this may or may not be true we cannot pretend to say; but it is to our minds a trivial and unimportant matter compared with the larger issues at stake. It is fair to say, moreover, that the greatest weakness in our present system of waterway improvement is its lack of expert planning. The Corps of Engineers, influenced doubtless by its military traditions, has confined itself generally to obeying orders—making such surveys and executing such works as Congress directed, but seldom taking the initiative. The members of the corps have done inestimable public service by their reports condemnatory of all sorts of crude and ill advised schemes; but to some extent the influence of the corps has been weakened by the very fact that it has never taken the responsibility for planning on a large scale for comprehensive works; or if it has done so, its reports have had too little weight with the general public to compel action by Congress.

A new policy in this respect is now emphatically demanded, and all the more so if the Government is to embark on large projects of waterway development. It is little short of absurd that millions should be spent on this river and that harbor and this strait, simply because some particular community—or rather a very few persons in some particular community—find that their personal interests or perhaps the interests of a particular locality would be enhanced by such an expenditure. We have had enough of log rolling river and harbor bills through by the aid of lobbying syndicates interested in water power projects which a projected navigation improvement work would benefit.

Even if the Corps of Engineers is to continue in sole charge of river and harbor works, there is need of a National Waterways Commission, made up of men of national reputation, which can take the initiative in planning our future system of waterways.

It is interesting to note that while Gen. Mackenzie refuses to endorse the recommendations for a permanent waterway commission, Senator Newlands, in another minority report, goes to the opposite extreme. He would have the Commission empowered not only to investigate and recommend projects, but also authorized, on approval of the President, to proceed with their immediate execution. He pleads for "large powers and a comparatively free hand" to be given to a body of administrative experts, and predicts that if the vast work which the Commission outlines has to secure Congressional approval at each successive step, indecision and delay may defeat the whole enterprise.

We said at the outset that the Commission has not as yet made any plan for inland waterway improvement. It has done, however, what is even more important. It has showed how numerous and vital are the interests which are closely connected with waterway improvement, and what it has to say on this subject deserves most careful study by engineers. Forest preservation equalizes the rate of run-off and thus increases the low water depth in the rivers. It also reduces erosion on the mountain sides and thus the amount of sediment carried down to form shoals in navigable waterways, perhaps a thousand miles away. Equalizing stream flow benefits water powers and storage of waters for flood protection or for slack-water navigation often creates new water power sites. The works of flood protection and swamp drainage are likewise closely related to the navigation interests.

What the Commission has to say regarding the relations between the railways and waterways likewise merits close attention. Its ideal of co-ordination between railways and waterways may seem utopian to some; but on no other basis can an intelligent and beneficial development of our waterways be based. It is this ideal that we have pursued when we have urged concentration of waterway development on the routes of greatest traffic; and when we have condemned the policy of developing waterways in sparsely populated regions, where the railways are able to carry all the traffic offered.

The railways must earn enough to pay their operating expenses and a reasonable return on the capital invested, or they will not continue to be operated and developed. If a waterway and a railway have to divide traffic which the railway could easily carry alone, the public will in the long run have to pay more for poorer service, because of the needless duplication of facilities.

The Commission thinks that unfair competition of railways with waterways is chiefly responsible for the disuse of the latter. We should be inclined to lay more stress on the fact that in most cases the all-rail route for shipments is actually more prompt and economical than the combined rail and water shipment. It must be remembered that only a small percentage of traffic begins and ends at a waterway. Freight must usually be loaded on cars anyway at the point of origin, and it is usually cheaper to let it stay in the same car till it reaches its final destination than to make a transfer to a vessel at some point.

It is no doubt true, however, that railway rates have been and are so adjusted as to take traffic away from the water routes. The right of the railways to do this is in fact recognized in the Interstate Commerce law, which permits a lesser charge for a longer haul where a railroad has to meet water competition on the longer haul.

The railways have also engaged and a[re] to continue to engage in water traffic [on] suitable routes are open, and unless thei[r] of competition are in some way restrict[ed] can defeat any competitor and so fix [the] their water lines as to continue to di[vert] traffic to the rail lines. Evidently ther[e] thing more than merely damming rivers a[nd] ging canals is necessary if a large w[ater] traffic is to be developed.

As to prospects that the Commission's [re]port will lead to action by Congress at the [next] session, we regret that not much favorab[le] be said. Congress is much more occupied [with] present session with matters of politi[cs] with the public interest. Notwithstandi[ng] marvellous expression of public opinion [in] the country in favor of waterway develo[pment] reports state that no river and harbor app[ro]priation bill is likely to be passed at the [next] session. In our national legislature there [are] hundred ways of blocking business for [every] single way of facilitating it. If the ex[ecu]tive departments of our governments—city, state and national—were as inefficient as the legislative departments the country would be in a sorry plight indeed.

However, the Inland Waterways Commission's report must have a great molding influence on public opinion. Followed up as it will be by the Conference on the Conservation of Natural Resources in May, there is hope that Congress may yet be induced to take at least the preliminary steps toward carrying into effect the Commission's recommendations.

THE NEW YORK BARGE CANAL VS. THE DEEP WATERWAY.

In our issue of Feb. 16, under the above caption, we called attention to some notable misstatements which were being widely circulated by the interests in New York and Buffalo that are supporting the New York Barge Canal enterprise.

That editorial brought to us a letter from Col. Thos. W. Symons, of the Advisory Board of Consulting Engineers on the Barge Canal work, in which our attitude toward the Barge Canal is criticised. Col. Symons' letter discusses a number of very important questions of interest to the profession. It is the established policy of Engineering News to give fair opportunity for arguments on both sides of a controverted question. We therefore publish Col. Symons' letter in this prominent place, appending to it our own comments on the questions which he brings forward.

Sir: Will you permit me to say a word regarding your editorial in Engineering News of Feb. 6 on "The New York Barge Canal vs. the Deep Waterway?" My estimation of the Engineering News in almost every other respect is so high that its persistent and to my mind baseless and illogical opposition to the great canal work which New York has inaugurated is really painful to me and a matter of sincere regret.

In the early days of the Barge Canal discussion, the News in some manner got started wrong and ever since has seemed to look at everything connected with the work through distorting glasses. It has apparently ignored the long continued investigations and the reports that have been made and is still imbued with the glamor of the ship canal idea, unsupported by facts and figures though it be, and in all probability utterly unattainable, at least for many, many years to come.

The above mentioned editorial in the News derogatory to the Barge Canal scheme and favorable to the Ship Canal scheme shows plainly that the attitude of the paper is based on several fundamental errors.

In the first place the editorial assumes that the people of Buffalo and New York, who are by far the most deeply interested in the canal and who will have to pay nearly all its cost do not know what is best for themselves or for the state, and that they are actuated by mean, narrow and sordid motives inimical to the best interests of the state at large. It is not a strong or commendable thing in a splendid and dignified technical paper like the Engineering News to impugn the intelligence and motives of great communities of commercial men like those of New York and Buffalo.

The second and greatest error of the News is the assumption that because the cost of transportation on the Great Lakes and on the ocean is reduced by increasing the size of the carriers the same rule will apply to

carri[illegible] operating in long canals like those of New York [illegible] going to a port like New York City.

A l[illegible] freighter carrying 8,000 or 10,000 tons, built heavy [illegible] strong for service on the open and ofttimes storm[illegible]aters of the Great Lakes, with everything arranged [illegible] taking in and discharging cargo in the shortest po[illegible]e time, with high powered engines and boilers sultab[illegible]or speed on these open waters and with an expens[illegible] crew, cannot carry its load through the 400 or [illegible] miles of narrow canals and rivers as cheaply as the [illegible]me load can be taken through in a number of barg[illegible] carrying 1,000 to 2,000 tons each for the following [illegible]asons:

1. T[illegible] ship costs much more per ton of carrying capacity [illegible]han the barges.

2. It [illegible]as a much more expensive crew than the barges [illegible]uld require.

3. It [illegible]ould make little if any better time than the barges.

4. It would be more liable to accident and delay in passing [illegible]ocks, bends, bridges, aqueducts, etc., and to going aground in high winds and storms than the barges.

5. It would be at far greater expense and delay in getting rid of its down cargo in New York than would the fleet of barges.

6. It ordinarily could not spend the time in New York harbor to accumulate a return load and must generally return empty.

To all this it may properly be added that the Ship Canal would cost at least twice as much as the Barge Canal, and the cost of maintaining and operating it would be three or four times as much, largely owing to the many draw and lift bridges that would be required, and which in turn would be awful nuisances and dangers to the railroads, trolley lines, and highways crossing the canals. Practically all the bridges crossing the Barge Canal will be fixed bridges, while all crossing the Ship Canal would be draw or lift bridges. So seriously would lake ships be handicapped as against barges in traversing a long canal with many locks and doing business in the harbor of New York, that I am thoroughly convinced that if a ship canal were built the greater part of the business on it would be done in barges that could be equally as well accommodated on a smaller canal, and that its occasional use by large lake vessels would not justify the maintenance and operation of the hundreds of draw bridges that would be required.

The prejudice against barge transportation on such a narrow and well protected waterway as the New York Barge Canal will be is unfounded, for the cheapest transportation in the world is now done in towed barges. This is the carriage of coal down the Ohio and Mississippi rivers and along our Atlantic seaboard. I haven't the statistics of this coal carriage but it is enormous, amounting to many millions of tons each year. The coal transportation along the Atlantic coast is largely done in barges, in spite of the fact that conditions for barge navigation are fraught with danger and are far from ideal as they will be on the Barge Canal which New York is building. If the Great Lakes and the ocean could always be as smooth and navigation on them as well protected as it will be on the Barge Canal, the carrying of freight on them would be done in barges to a tremendously greater extent than it is now.

Another fundamental error of the News, and it is an exceedingly common and widespread error, is that, with a 21-foot canal built and business on it done in large lake freighters a transfer of cargo would be avoided. This would not be true in the great majority of cases. In almost every instance the same number of cargo transfers would be required, but the place of the transfers would be changed. In one case the transfer would take place from lake vessels to barges at a lake port, say Buffalo or Oswego, and the barges would then go through the canal to New York where the loads could be scattered and distributed directly to various points. In the other case the lake carrier would go through the canal to New York where she must transfer her cargo to lighters or barges which would take it to its various points of destination. In one case the transfer would take place in the comparatively cheap lake port, and in the other at the much more expensive port of New York, one of the most costly ports in the world in which to do business.

The necessity for the cargo transfer from the lake vessel to lighters in the harbor of New York arises from the method of doing business in this port. Nearly all the freight shipped from New York goes as berth cargoes in the great ocean liners. These liners come into port and go to their docks where they lie until ready to leave on their advertised sailing days. All freight must be taken to them. The lake freighters could not go alongside and unload directly into the liner, which ordinarily could take but a small part of her cargo anyway. The lake freighter would have to lie somewhere in the harbor while lighters were engaged in transferring her cargo to various ocean ships or to other places. She might get quick dispatch by going to an elevator, but this would mean an additional transfer, into the elevator, and later out of the elevator into a lighter and from the lighter to the ocean vessel or other places.

The canal barges, each holding about an ordinary berth cargo lot for an ocean liner, could on arrival go directly alongside and discharge cargo, or they could be distributed to mills, factories, warehouses, etc., in New York, Brooklyn, the Jersey cities and points on Long Island and the Sound. Then they could move about and pick up cargo for the return trip and altogether could get a quicker dispatch and at less expense than could the lake carrier.

It can be stated positively that a ship canal across New York would not avoid a cargo transfer if used by large lake freighters, but would simply change the locus of the transfer from an inexpensive lake port to the very expensive port of New York, a distinct disadvantage.

And I desire to protest most vigorously against your animadversion on the people of Buffalo and New York for the stand they take on the canal question. The people of these cities as represented by their chambers of commerce, produce exchanges, manufacturers' associations, boards of trade and transportation, canal associations, newspapers, etc., etc., want the Barge Canal and not the Ship Canal for the reason that they believe one to be attainable and the other unattainable; because they have studied the problem of transportation and especially the canal problem in all its widespread ramifications and have had actual practical experience in transportation on lakes, ocean and canals; because they know the conditions that prevail and must continue to prevail in lake ports and in the port of New York; and because they believe that the Barge Canal will furnish the cheap transportation which the State requires to enable it to compete with its trade rivals and maintain its proud position as the Empire State.

The men of these two cities are practical, hard-headed business men and not inexperienced theorists.

I have lived among the people of Buffalo for eight years, and I know them to be as patriotic, wise, broad-minded and liberal as any people in the world, and that they and the newspapers of the city are actuated by any such mean and narrow reasons in favor of the Barge Canal as intimated and charged in the Engineering News editorial I most emphatically deny.

To throw away the Barge Canal in its present status and adopt the plan of a ship canal to be built by the general government would be much like a man throwing away a handful of silver dollars to go after the pot of gold dollars at the foot of the rainbow. With the ordinary routine expenditures of the Government exceeding the revenues by over $100,000,000 per year, the prospect of getting it to expend $200,000,000 in building a ship canal across the State of New York is not dazzling but looks very remote to me.

The Barge Canal work which the State of New York is building is one of the greatest engineering works of the world, and in some respects the greatest, and it is being carried on by engineers and it should have the support of such a great technical paper as the Engineering News.

Very respectfully yours,

Thomas W. Symons,

Lt.-Col. Corps of Engineers, U. S. Army, Member Advisory Board of Consulting Engineers, N. Y. State Canals.

20 Lafayette Square, Washington, D. C., Feb. 8, 1908.

As many of our readers know, Col Symons is the real originator of the New York Barge Canal. It was his study of the economics of waterway transportation from the Lakes to the Atlantic, made when he was in charge of the U. S. Engineer Office at Buffalo that led finally to the State of New York taking up the building of the Barge Canal. We do not for a moment question his sincerity and good faith in his advocacy of the Barge Canal from its first inception down to the present time.

Neither did we question, in the editorial above referred to, the sincerity and good faith of the business men of Buffalo or New York City, taken as a whole. Ninety-nine out of every hundred business men in these cities have only a vague general knowledge of the canal matter. They have simply formed the opinion from the current newspaper articles that the Barge Canal is a necessary feature for their city's commercial salvation, and that it is being opposed by the secret machinations of the wicked railway companies. Very, very few of the business men who make up the Chambers of Commerce and other commercial associations have either the time or the expert knowledge necessary to form an independent judgment on the Barge Canal question.

Our reference to the Buffalo and New York City interests, to which Col. Symons takes exception, was to the interests which control the freight transfer business in these ports. The combinations to fix excessive prices for freight transfer at Buffalo and New York have been the subject of legislative investigation in years past. In the report of the New York Canal Commission of 1899 (of which Col. Symons was a member) it was shown that the charge for handling a bushel of grain at Buffalo and New York was 2.1 cts., while the freight on grain all the way from Chicago to Buffalo as an average of several years was only 1¼ cts., and the Commission said: "We think the cost of rehandling is out of proportion to the cost of transportation."

It was entirely natural that the interests which control this enormously profitable freight transfer business should take the lead in promoting the Barge Canal. It is entirely natural, too, that the business and real estate interests of these cities should wish to further whatever transportation system would, as Col. Symons says above, "enable the state to compete with its trade rivals."

This is, of course, the usual point of view. We, however, from our position as a national journal are obliged to consider such questions as these from a larger standpoint. It is not what kind of canal will be best for Buffalo or New York City alone, or even for the State of New York; but what will give the largest measure of benefit to the entire territory which it serves—and as we conceive it, the extension of Lake transportation to the Atlantic seaboard would bestow benefits throughout the length and breadth of the continent.

The Board of Engineers on Deep Waterways in its report said:

> Any project undertaken by the Government should be of a national and not a local character, benefiting many and varied commercial interests and exerting its influence over as great an extent of the country as possible. It is easily conceivable that a barge canal of moderate dimensions, requiring transfers at Buffalo and New York, might be of more direct benefit to the State of New York than a canal of sufficient dimensions for the uninterrupted passage of ships; but much of this benefit would be at the expense of the producers and shippers of other parts of the country. Moreover, with such a canal the large interests of shipbuilding [of ocean vessels on the Lakes] and winter traffic for the Lake fleet would be unprovided for.

And now—since it is charged above that Engineering News "started wrong" on the Barge Canal proposition—it may be proper for us to say a word as to our past and present attitude on this subject:

We hold—as practically all engineers hold, we believe—that the day of *the artificial canal* as a transportation route has passed. It was not the evil machinations of the railway companies that caused the abandonment of the canals which flourished in the first half of the last century, but the fact that the railway was a more economical machine for carrying goods from their origin to destination.

But we hold also that natural waterways of good capacity should be improved for navigation, and that the most important of these natural waterways should be connected together by artificial canals, so that traffic can pass from one waterway to another without the expense and delay necessary for transhipment.

It is because the Barge Canal has been from the start planned *as a waterway by itself* and not as a link in a route for through transportation that we have felt obliged to oppose it. The recent efforts of the Advisory Board to increase the depth of the canal were blocked by the interests we have referred to; but the width of the locks was increased because that change would not make possible the construction of vessels fit to navigate the lakes as well as the canals.

In other words, every move on the part of those who, like Col. Symons himself, would seek for the Barge Canal the largest field of usefulness, has been opposed by parties whose interest in the Barge Canal is because of expected benefits to their own business or their own city.

As to the 21-ft. deep waterway, our advocacy of it is based on the report of the Federal Deep Waterway Commission of 1900, made up of Col. C. W. Raymond and Messrs. Alfred Noble and Geo. Y. Wisner. We know of no place where the report of those able engineers has been anywhere shown to be in error. It is the facts and figures in that monumental report on which we

base our advocacy of the deep waterway; and we know of no facts and figures anywhere which contradict them.

The fact is that when the New York Canal Commission of 1899 (of which Col. Symons was a member) made its investigation and report in favor of the Barge Canal project, the surveys for the Federal Deep Waterway were still in progress. Until these surveys were completed, there was no means of knowing whether the Deep Waterway was feasible or not. We ourselves were originally doubtful as to the practical possibility of providing continuous navigation, so that good sized Lake vessels could come down to the Atlantic and make the voyage a commercial success. Col. Symons will find no support of the Deep Waterway project in these columns prior to the report of the Board of Engineers upon it.

For a complete answer to Col. Symons' letter we would refer our readers to the above report. One or two points which he raises, however, are of such general interest that they deserve attention here.

We entirely agree with Col. Symons that for inland navigation on canals and rivers, where broad, shallow hulls can be used, great depth of water is not necessary for economic transportation. If the New York Barge Canal were to stand by itself, or if it were connected to a network of inland rivers, we should regard the present depth as ample. What we claim is that it is worth while to make a deep waterway instead of a barge canal *to secure the advantage of through passage between all the Great Lake ports and all the ports on the Atlantic seaboard without transfer of cargo.*

But Col. Symons says the heavy built Lake steamer "cannot carry its load through the 400 or 500 miles of narrow canals and rivers as cheaply as the same load can be carried through in a number of barges."

If Col. Symons will refer to the "Report of the Board of Engineers on Deep Waterways," p. 244, he will find that of the 477 miles from Buffalo to New York by the proposed Deep Waterway, only 102 miles are in actual canal and about 75 miles more is in canalized rivers with channels 250 to 1,000 ft. wide. The balance of over 300 miles is in open lake and river navigation. The average speed of Lake vessels through this waterway is estimated as 10.67 miles per hour, including the time taken for the passage of locks. Thus a vessel would go from Buffalo to tidewater at New York in substantially 48 hours. It is because the proposed Deep Waterway would furnish a capacious and speedy channel for the Lake vessels that it does deserve attention and support. If it were indeed a narrow ditch, nearly 500 miles long, there would be much force in Col. Symons' claim that Lake vessels could not profitably navigate it.

Col. Symons thinks we make a fundamental error in assuming that the Deep Waterway would save a transfer of cargo. Because big lake freighters cannot lie alongside the large ocean steamers at New York City's piers, he thinks they would have to discharge cargo into lighters anyway.

We have no doubt at all that the steamship lines entering New York prefer the Barge Canal to the Deep Waterway. With the latter available, lake freighters might come down to the port of New York and deliver cargo to tramp steamships, and that would make unpleasant competition for the big steamship companies.

From our point of view the fundamental error made by Col. Symons and others who defend the Barge Canal in good faith is that they have studied the Barge Canal as if its chief function were the handling of bulk freights and particularly the delivery of grain in the holds of transatlantic steamships.

But statistics showed years ago that the domestic traffic between the East and the West was several times as great as the export and import traffic. The populous states east of the Great Lakes consume far more of the West's products than all that is carried across the sea.

Why confine our ideas of waterway transportation between the East and the West to a terminus at the port of New York? Any vessel fit to navigate the Lakes can navigate Long Island Sound and can even reach Boston, without going into the open ocean, through the Cape Cod Canal, now under construction. Such vessels could certainly go as far down the coast as Delaware and Chesapeake Bay in all ordinary weather. To so build Lake vessels as to be fit to go safely anywhere on the Atlantic from Portland to Jacksonville would add very little to their cost.

If the taxpayers' money is to be spent to provide a waterway from the Lakes to the Atlantic, by all means let it be so planned as to make possible the widest measure of competition. We object to the Barge Canal proposition because it proposes the expenditure of $100,000,000 for a waterway which when built will still leave shippers subject to the charges of a combination of freight transfer companies operating in the harbors of Buffalo and New York.

It needs no great foresight into the future, too, to see that combinations will control the rates on freight carried by the regular ocean steamship lines. To offset such combinations, let the widest possible opportunity for competition be opened. Even if the barge system with its double transfer were the most economical, the opportunity to run independent tramp steamers to ports on the Lakes and to run Lake vessels down to the coast would be of enormous value in preventing combinations of steamships and barge lines and elevator and lighterage combinations from unduly raising rates.

We have advocated the Deep Waterway because it has been shown to be feasible and economically practicable by one of the most thorough surveys ever made on an engineering enterprise. We have advocated the Deep Waterway because we look forward to seeing steamships load with grain and flour at the wharves of Duluth or Chicago and discharge their loads in the harbors of Boston or Baltimore or Philadelphia as well as in New York City. The cotton goods from Fall River and the shoes from Brockton can be loaded on a steamer and not disturbed until they arrive at Cleveland or Milwaukee. Ice from Lake Superior can be delivered at Savannah or Jacksonville. The phosphates of Florida can be laid down at the fertilizer factories of Chicago. Refrigerator ships can load at the packing houses of Chicago and discharge into cold storage warehouses at every port on the Atlantic coast.

We are familiar with all the arguments presented to show that a vessel cannot sail both the lakes and the ocean economically, and we accept them so far as they show that the recently built huge freight liners are certain to stick to the ocean. But we must not forget that the great bulk of ocean traffic is still carried and is likely long to be carried in vessels of moderate size and draft, which could navigate the proposed Deep Waterway with ease. It is unreasonable to expect that fruit steamers from the West Indies and Central America will land their cargoes direct at ports on the Great Lakes; or that the vast mineral wealth of South America, which the next generation is to develop, may be brought direct through the Panama Canal and laid down by vessels at Chicago or Cleveland.

We believe no man of the present day is wise enough or farsighted enough to fix a limit to the development of transportation between the interior of the American continent and its eastern seaboard, where already the greatest traffic movement in the whole world is carried on.

New York may if it chooses proceed with its $100,000,000 canal designed for barges and arranged with fixed bridges, so that by no possibility can it be used for through navigation; but sooner or later, the public demand for a real waterway connection between the Great Lakes and the Atlantic will have to be satisfied.

LETTERS TO THE EDITOR.

Advertising Defacements in Public Places.

Sir: In reference to the matter of advertising defacements [Eng. News, Feb. 13, 1908] I would like to point out that if each individual who did not approve of the promiscuous advertising of the present day would let it be generally known that he did not patronize firms which made a practice of such methods, I think there would soon be an abatement of the evil, for I can always find goods as good if not better than those advertised by such methods. Respectfully,

E. Raffin.

146 Oakland St., Brooklyn, N. Y., Feb. 17, 1908.

A Wooden Floor for a Street Foundation.

Sir: I enclose a photograph showing a blanket foundation (?) for a fill for widening the roadway over marsh land between Oakland and Alameda.

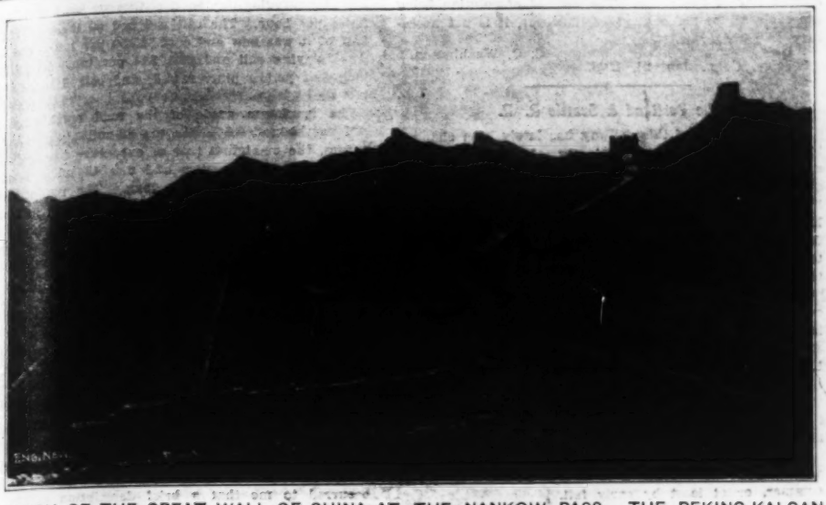
This blanket is composed of one layer of 2-in. and one layer 1-in. red wood planks laid crosswise, costing about $5 per cu. yd.

The lumber cost $14.50 per M. and the nails and labor in placing it would certainly add at least $1 per M. to this. The filling on this is to be made by hydraulic dredge at a cost of about 12 cts. per cu. yd. Is not this wooden blanket too costly in proportion to the benefit it gives? About 250 M. ft. were used in the entire distance, making a total bid of $3,865.

This wooden blanket will be at an average depth of about 3 ft. 6 ins. under the finished surface, which will probably be one monolithic slab of concrete from 6 to 8 ins. in thickness made by first rolling good hard rock then filling the voids by grouting with a 1 to 2 mixture of cement and sand.

The blanket will not increase the bearing area supporting the roadway but will reduce the dead load on the foundation some 20 lbs., more or less per sq. ft.

PLANK FOUNDATION FOR A STREET FILL ACROSS A SWAMP, OAKLAND, CAL.



BRANCH OF THE GREAT WALL OF CHINA AT THE NANKOW PASS. THE PEKING-KALGAN RY. WILL TUNNEL 200 FT. BELOW THIS POINT.

To what extent will the bearing area be increased under a concentrated load on a slab as above mentioned?

Yours very truly,

J. G. Hult.

1043 Taylor Ave., Alameda, Cal., Jan. 21, 1908.

[Perhaps the engineer who adopted this wooden platform for a street fill went to needless expense; but without more knowledge of local conditions than is possible to one located the breadth of a continent away we shall not attempt to indict his judgment. The question how much of a fill one can place on the surface of a swamp without risk of settlement is one not to be solved by mathematics, nor is there any substitute that we know of for intimate practical knowledge of the local conditions.—Ed.]

The Peking-to-Kalgan Railway, China.

Sir: In your issue of Jan. 9, 1908, I was interested in Mr. Birkhäuser's article on the Peking-to-Kalgan Ry. and take the liberty of sending you some photographs of construction work on this road, taken in April, 1907.

The building of this railway is of particular interest as it marks an attempt by the Chinese to carry on their own railway construction, without the aid of foreign engineers. The progress at present seems to indicate that China is fast nearing the time when she need no longer depend upon other nations for the successful completion of her engineering works. This independence may prove a vital necessity if she is to restrain the advances of her too-ambitious neighbor.

Chinese engineers who were educated in America and abroad are doing most of the responsible work of location and construction on this railroad, for as yet not much dependence can be placed upon the native engineers educated entirely in China.

Being in Peking last April, I took the opportunity of seeing what I could of the construction of this railway by riding along the line from Nankow (the terminus at that time) to the Nankow Pass, a distance of about thirteen miles. Rails were then laid only a mile or so beyond Nankow, and work was going on at several points ahead with stretches of unbroken ground intervening.

This section of the line parallels the ancient and much used caravan route to Kalgan, which is a city about 125 miles northwest from Peking. The railroad ascends the tortuous valley of a mountain stream nearly to the Pass, where a tunnel begins that carries the line across the divide at a maximum depth below the surface of about 200 ft.

PRESENT METHOD OF TRANSPORTATION ON THE PEKING-KALGAN ROUTE. DROMEDARIES HOMEWARD BOUND FOR KALGAN.

On the section of line in question, the construction of tunnels and roadbed seemed to be first-class throughout. There was little attempt to use labor-saving appliances, owing, no doubt, to the high cost of machinery and the low cost of native labor. The only drilling that I saw was done by hand. On some of the earth-work, light rails and push cars were used, but usually coolies carried the dirt in wicker baskets hung from a pole. The line crosses the stream several times, and at some points careful protection against washouts will be necessary.

It was interesting to see that in some of the plans and drawings, English words and dimensions were used, though most of the lettering was in ideographic Chinese characters.

A branch of the Great Wall of China crosses the Kalgan route at the crest of the Nankow Pass; and although for centuries it has resisted raids and raiders, it finds itself helpless against the present invasion. Even the dromedaries, now plodding steadily along with their burden of freight, will soon be looking for another job.

Yours truly,

Roger W. Toll.

1654 Mass. Ave., Cambridge, Mass., Jan. 14, 1908.

The First International Highway Congress: Paris, 1908.

Sir: The Minister of Public Works of France has decided that an International Highway Congress shall be held at Paris at the end of 1908. A committee of organization will shortly be constituted by the "Commission of inquiry into remedies against the dust and for the preservation of roads," which commission was appointed by the Minister of Public Works in 1905 at the request of the "Anti-Dust League."

This congress will be devoted to the construction and maintenance of roads; the comparative study of different paving materials; the cost of laying and maintenance, and their respective resistance to modern methods of locomotion. It will not deal with questions as to policing the roads (speed regulations, accidents, etc.). The commission has decided to include in the committee of organization, not only those who construct the roads, but also those who use them. Thus the Automobile Club, the Touring Club of France, and the Anti-Dust League, will each be represented by its president and by delegates. On this committee will also be represented the public highway authorities of France.

The service of the national roads in France depends entirely upon the Minister of Public Works, who distributes the budget of expenditure. This service will be represented by the ministerial commission already named, by several engineers of bridges and roads (the "Ponts et Chaussées") and by the chief of the ministerial service. The departmental highways and the great main roads of communication come under the control of the Minister of the Interior, so far as their inspection and supervision are concerned, but the funds devoted to them are expended by the "conseils generaux" or county councils.

Furthermore, the committee will organize for the occasion of this congress, with the assistance of the city of Paris, an international exhibition of machinery used for the construction, maintenance and cleaning of streets and roads.

The Minister of Public Works, Mr. Louis Barthou, in a speech made at the first meeting of the committee, announced that he would request the Minister of Foreign Affairs to invite foreign nations to participate in this international congress for the adaptation of roads to modern conditions of traffic.

Dr. Guglielminetti, President Anti-Dust League.

78 Avenue Malakoff, Paris, France, Jan. 16, 1908.

ROADBED CONSTRUCTION, PEKING-KALGAN R. R. (CENTER LINE STAKE AT THE RIGHT.)

CONSTRUCTION WORK ON THE PEKING-KALGAN R. R. NEAR NANKOW PASS. TUNNEL PORTAL IN THE DISTANCE.

A Railway Location Problem: To Connect a Crossing of a Straight and Curved Track by a Curve, when Both Frog Angles and the Position of Frog in Straight Track are Fixed.

Sir: The following problem came up in the office of the Oregon Short Line at Salt Lake City. A crossing of a curved track intersecting a straight track is to be connected by a curve, when both frog angles are fixed and the location of the frog (or the switch point) in the straight track is fixed. A solution of the problem is given herewith.

Given: α, the angle of intersection of the center lines of the straight and curved track; g, the gage; R, the radius of the curved track; the frog angles F_1 and F_2; and d, the distance along the straight track from the intersection of the center-lines to the beginning of curve. Required, the radius of the curve connecting the frogs F_1 and F_2.

SOLUTION:

In triangle ABO of the accompanying sketch,

$$BO = R \cos \alpha,$$

and $$AB = R \sin \alpha.$$

In triangle CDO,

$$DO = BO - \tfrac{1}{2} g = R \cos \alpha - \tfrac{1}{2} g,$$

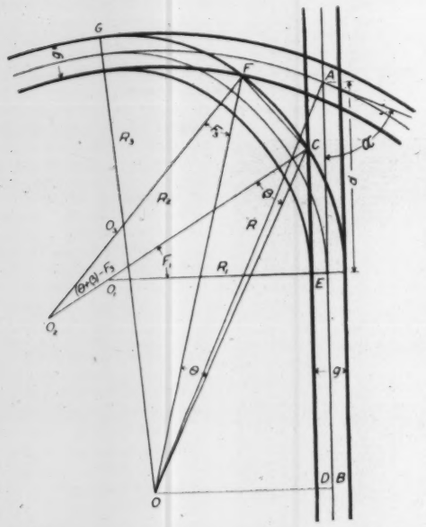
$$CD = AB - AE + EC = R \sin \alpha - (d - l)$$

where $l = EC =$ the lead for frog F_1.

Then, $$\tan OCD = \frac{DO}{CD} = \frac{R \cos \alpha - \tfrac{1}{2} g}{R \sin \alpha - (d - l)}$$

and $CO = DO$ cosec OCD.

From these equations the angle OCD and length CO can be computed.



Determination of Curve Connecting a Crossing of Straight and Curved Track When Both Frog Angles and the Position of Frog in Straight Track Are Fixed.

The angle O_2CO, which for convenience we will call β, is equal to angle O_1CO, is given by:

$$O_2CO = \angle O_2CD - \angle OCD = (90° - F_1) - \angle OCD.$$

In triangle OFC, let θ represent the unknown angle COF. CO is known, and $FO = R - \tfrac{1}{2} g$. Now, $\angle C - \angle F = (\angle O_2CF + \beta) - (O_2FO - F_2)$; and as $\angle O_2CF = \angle O_2FC$, we have $\angle C - \angle F = \beta + F_2$. As β and F_2 both are known, call their sum Y, or $\angle C - \angle F = Y$.

Also, $\angle C + \angle F = 180° - \theta$.

By trigonometry, $$\tan \tfrac{1}{2} (C - F) = \frac{c - f}{c + f} \tan \tfrac{1}{2} (C + F).$$

Substituting, $$\tan \tfrac{1}{2} Y = \frac{(R - \tfrac{1}{2} g) - CO}{(R - \tfrac{1}{2} g) + CO} \tan \tfrac{1}{2} (180° - \theta),$$

or, $$\cot \tfrac{1}{2} \theta = \frac{(R - \tfrac{1}{2} g) + CO}{(R - \tfrac{1}{2} g) - CO} \tan \tfrac{1}{2} Y.$$

All members of the right-hand side of this equation being known, the angle θ can be computed. Also since $C - F = \beta + F_2$ and $C + F = 180° - \theta$, we find

$$C = \frac{180° - \theta + \beta + F_2}{2},$$

from which C becomes known.

$$\frac{FC}{FO} = \frac{\sin \theta}{\sin C} = \frac{FO}{R - \tfrac{1}{2} g} \quad \therefore \quad FO = \frac{(R - \tfrac{1}{2} g) \sin \theta}{\sin C}.$$

In triangle FO_2C, the angle $FO_2C = (\theta + \beta) - F_2$ by geometry.

$$R_2 + \tfrac{1}{2} g = \tfrac{1}{2} FC \text{ cosec } \tfrac{1}{2} [\theta + \beta - F_2].$$

From this, $R_2 + \tfrac{1}{2} g$ can be computed and thus R_2 is found.

There is of course the case of this layout from the convex side of the curve. The method of solution being the same as for the case given, however, it is not necessary to consider it.

C. C. Washington.

Greeley, Colo., Jan. 24, 1908.

The Portland & Seattle R. R.

Sir: The name of this railway has lately been changed to Spokane, Portland & Seattle Ry. In January a part of the line from Kennewick down the Columbia was opened and freight train service inaugurated, now reaching to Lyle. The opening to traffic of the line from Kennewick to Vancouver is now set for March 16, but it does not yet seem to be fully decided whether the trains will run on to Portland by way of Kalama over the Northern Pacific, as was first intended.

The present Northern Pacific Ry. branch from Vancouver to Kalama, down the right bank of the Columbia, is being graded for double track.

This division will be used by Northern Pacific trains between Seattle and Portland, which will run from Kalama to Vancouver and thence over the S., P. & S. tracks to Portland by way of the bridge across the Columbia River, instead of ferrying across at Kalama, as now.

It is expected that the bridges over the Vancouver and Willamette Rivers will be completed some time this summer, or at least by early fall.

Very truly yours,

W. P. Hardesty.

Portland, Ore., Feb. 25, 1908.

Sir: In your issue of Feb. 13 I note on p. 173, in the article on the Portland & Seattle R. R., some slight apparent errors.

First. The map does not show, as it should, to be complete, the Astoria & Columbia River R. R. built as an independent line, but now under the management of the Portland & Seattle R. R., or as its name now is, the Spokane, Portland & Seattle. The Astoria & Columbia River R. R. extends down the south bank of the Columbia to a terminal at Astoria near the mouth; and a seashore extension runs across a bay to various points along the shore. At Goble, 40 miles from Portland, connection is made with the Northern Pacific line for Portland.

Second. Your article would seem to imply that the Columbia River is the only one which cuts through the mountain range called in Oregon and Washington the Cascade, and in California the Sierra Nevada. If reference is made only to navigable streams or even those in low altitudes, this is correct. But there are at least two rivers of considerable size which, though rising at high altitudes, nevertheless cut completely through the mountain range from east to west, and though not navigable except for small craft, are of great importance as probable railroad routes in the near future, from the high table lands of the interior to the coast.

The first of these rivers is the Klamath, which rises in southern Oregon, where the Government is spending several millions on a reclamation project; crosses thence into northern California, and runs in a very tortuous course but in a general southwesterly direction to the Pacific Ocean.

The second is the Pitt, which also has its source near the boundary between Oregon and California, and runs also in a general southwesterly direction, through a portion of northern California to a junction with the Sacramento River a short distance above the town of Redding.

Respectfully yours,

T. H. Curtis.

Box 112, Portland, Ore., Feb. 18, 1908.

"The Cheapest Railway in the World."

Sir: On p. 548 of Gillette's "Hand Book of Cost Data," the cost of the "Cheapest Railway in the World," is given as $3,440 per mile for roadbed and track complete, the length of the railway being 19 miles in the State of Georgia.

During the winter of 1897 and 1898, the writer had in charge the location and construction of an inexpensive line of railroad from Ft. Bliss, El Paso, Texas, to Alamogordo, N. Mex., a distance of 82 miles. The average cost per mile of that road was as follows:

Grading, 5,300 cu. yds. at 10c.	$530.00
Bridging	70.00
Track material	3,326.00
Track laying	275.00
Telegraph line	125.00
Total	$4,326.00

The cost of side tracks, water and coaling stations, etc., was about $600 per mile, making the total cost slightly over $4,900 per mile, exclusive of general expenses.

The contract price for earthwork was 10 cts. per cu. yd. and there was no overhaul. There were only 250 yds. of rock in the grading. There is one stretch of track 26 miles long without a water opening of any kind, and none has ever been required during the ten years of the life of the road. The tracklaying included the complete lining and surfacing and ballasting of track on dirt, and construction trains ran thereon with miles per hour. The rail weighed 60 lbs. p half of it was new and cost $25.50 per ton. was relaying rail and cost $14 per ton. long leaf yellow pine, sawed, and cost del per tie.

The maximum grade of the road north and southbound 0.5%. In the 82 miles, th curves, the maximum rate of curvature bei is one tangent 22 miles and one 43 mile shortest tangent is a mile long. The roa bankment was 14 ft. wide and in cuts 16 ft. practically no cutting. Yours very truly

J. L.

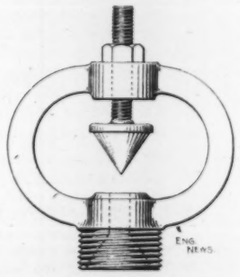
El Paso, Tex., Feb. 12, 1908.

[The reference in the first line of letter is to a paper by Mr. Arthur P. in the Transactions of the American Societ of Civil Engineers, Vol. 23, 1890.—Ed.]

A Sewage Sprinkler Nozzle Used on Experimental Percolating Filters at Worcester, Mass.

Sir: While reading in your issue of Jan. 1908, the paper on "Studies of Sewage Distributors for Sprinkling Filters," and the editorial upon the same subject, it occurred to me that a brief description of the nozzle used at Worcester, Mass., on the experimental filters might prove to be of interest to some who are making a study of this latest method of sewage disposal. It is a modification of the Columbus type and the accompanying sketch will show at a glance its principal features. At the base of the inverted cone is a ring or shoulder which projects about 1/16-in.; the cone is attached to a screw, provided with a check nut, and is easily adjusted to suit different heads.

One day a foreman, passing by a filter on which the Columbus type of nozzle was in operation, picked up



Sewage Sprinkler Nozzle Used on Experimental Percolating Filters at Worcester, Mass.

from the ground a rubber washer and applied it to the base of the cone. The improvement in the distribution was so marked that the suggestion was immediately adopted. Our experiments in the distribution of sewage upon trickling filters have been confined to nozzles and the above is by far the most efficient we have found.

We are about to install upon our experimental filters nozzles with ¼-in. aperture in the endeavor to reduce the rate of application to 1,000,000 gals. per acre per day.

Very truly yours,

Matthew Gault, Supt. of Sewers.

Worcester, Mass., Jan. 24, 1908.

Applying the Engineering News Formula for the Bearing Power of Piles.

Sir: In using the Engineering News formula

$$\left(L = \frac{2wh}{s+1} \right)$$

for computing the bearing power of piles I find the following:

A pile was driven with a penetration of 20 ft. in sand and silt. From the last blow L was found, from the formula, to be 10,000 lbs. After remaining at rest for 24 hours the first fall of the rammer caused no penetration of the pile, but the second fall caused a slight penetration which gave the value of L = 60,000 lbs. After several blows the pile moved with about the same rapidity as before being allowed to rest. What would you consider the safe bearing power of the pile?

(Signed) X. Y. Z.

Feb. 10, 1908.

[The man who is—or should be—most competent to determine what the bearing power of a pile should be, is the engineer in direct charge of the work. The Engineering News formula originated by the late A. M. Wellington when editor of this journal, was intended as an aid to the engineer in the application of his best judgment, and is by no means a cast-iron rule. To rightly understand the use of the formula, one should study Mr. Wellington's full discus-

sion of it. He stipulates, for example, that the penetrati[illegible]s, shall be the average for the last few blo[illegible] shall be fairly uniform *and a considerable amount.* Otherwise brooming of the point of [illegible] pile or crippling somewhere in its length u[illegible]r a heavy hammer may be mistaken for penet[illegible]tion.

In orde[illegible] to judge the safe load for a pile, the value of [illegible] the quantities used in the equation should [illegible] known as well as the behavior of other pil[illegible] driven in the ground adjacent. It is by averag[illegible]ng the results obtained with many piles that [illegible] safe load can be worked out with the aid of the Engineering News formula.

In the [illegible]se above cited, it is well known that a pile left to rest will show much more resistance to driving for the first blow and usually for several blows than when it is first driven. We can [illegible]ee no reason, therefore, from such information as is above given, for increasing the load above the five tons indicated by the first day's driving.—Ed.]

Pearson's Work on the Hudson Tunnel—A Correction.

Sir: In the historical summary of the old Hudson Tunnel enterprise, in your issue of Feb. 27th, there was a slight inaccuracy in the statement of dimensions of the shield and tunnel when the shield method was first installed, to which I would call your attention.

The shield, which was built in Great Britain, was 19 ft. 11 ins. in external diameter and 10 ft. 6 ins. long over all.

The cast-iron lining, at the start, had an inside clear diameter of 18 ft. 2 ins., with an outside diameter of 19 ft. 6 ins. Each ring was 20 ins. wide, and was composed of nine segments of different lengths (the longer segments being at the bottom) and a key. There was 1¼ ins. metal in the back of the segment, with flanges 8 ins. deep and 1½ ins. thick. The joints of these segments were unplaned, and the approved plan called for the placing of strips of creosoted wood between the longitudinal flanges of the segments. The rings were erected with their longitudinal joints continuous, as was the English practice at that time.

On account of serious weakness developing, a new and heavier lining was substituted, after 286 rings of the first type were erected. In the new type, all joints had planed faces, and the ring was composed of eleven segments and a key, all of the segments with the exception of the key and two adjoining plates being interchangeable. The thickness of metal in the back of the segment was increased to 1½ ins. and the depth of flange was increased to 9 ins.

After 350 rings of this second type were placed, the design was again changed, reducing the depth of flange back to 8 ins., but increasing the amount of metal in the flanges to 2¼ ins., the metal in the back of the segments remaining the same, viz., 1½ ins. This last type was used until the final shut-down.

Yours very truly,

Walton I. Aims.

45 Broadway, New York City, Feb. 29, 1908.

[The shield built for Pearson & Son's work and the first lining used by them were described in Engineering News of March 15, 1890, p. 257, and April 12, 1890, p. 354. The dimensions there agree with those stated by Mr. Aims, except that the flanges are described thus: Vertical (circumferential) flanges, 8 × 1⅛ ins.; horizontal (longitudinal) flanges, 7¼ × 1⅛ ins. The bolts used were of 1¼-in. diameter. We understand that the original type of lining, having unplaned joints in which strips of creosoted wood were inserted, did not hold the circular shape, but flattened considerably. Many longitudinal cracks also developed in this lining, as noted in our issue of Aug. 22, 1891, p. 155, and June 30, 1892, letter of Wm. R. Hutton, p. 660. Some bad transverse cracks also appeared.

Three views of the shield under construction at the shops of Wm. Arrol were given in our issue of July 19, 1890. These views show the shield to have been equipped with hinged doors. It was stated that the shield was "now under construction" in England, but this is an anachronism, as the shield was erected in the shield-chamber in the tunnel from March 24 to May 23, 1890, and by July was well on its way toward the New York shore. However, a second shield of the same construction was built for the New York end, and this may have been the one referred to. These shields had hinged doors, but the doors were not used very extensively.

The lining, we are informed, was provided with grouting-holes, contrary to a statement in our early description of the lining. Grouting was regularly done, for a distance of several hundred feet, but was then discontinued, because the silt flowed readily enough to fill the space left by the tail of the shield.—Ed.]

The Inventor of the Automatic Car System.

Sir: Your issue of Feb. 13 contains a very full description of the automatic railway which is so largely used for handling coal and other bulky materials. I regret to note, however, that not even proper acknowledgment has been given to Mr. C. W. Hunt, President of the C. W. Hunt Company, of New York City, who invented this automatic railway, and developed it substantially to the present degree of perfection, more than thirty years since. This device has been of exceedingly large service to the industrial world, and it seems to me that it is ungracious to publish a description of it without an acknowledgment of indebtedness to the inventor.

Very respectfully yours,

John Lyle Harrington.

Waddell & Harrington, 608-611 New Nelson Bldg., Kansas City, Mo., Feb. 14, 1908.

[Proof of this letter was sent to the author of the article. His reply follows.—Ed.]

Sir: Relative to the letter of Mr. John Lyle Harrington, I would state that the publication of Mr. Hunt's name in connection with the article on automatic railways, was carefully considered by me before the article was published. I believe, however, that a technical article should in no way appear to be an advertisement, unless the machine described is manufactured by only one firm. If, as in the case of these car systems, there are a number of manufacturers engaged in the work, it hardly seems justice to mention only one. Not only the C. W. Hunt Co., but the Mead-Morrison Co. and the Geo. Haiss Mfg. Co., manufacture these systems, and there are no doubt others, unknown to the writer. These systems vary only slightly in the construction of the car, etc.

I had no intention of being "ungracious" in failing to mention Mr. Hunt in this connection.

Relative to the article itself I would like to add a few notes of some interest on points of design and construction which were not completely covered.

The triangle-weight need not necessarily be located, at the end of the trestle, where shown by Fig. 4, p. 166, but may be located anywhere along the straight part of the track as mentioned in this article, or even may be placed on a continuation of this tangent at either end. The size of the triangle varies with the length of the track and the weight of the cars used. With one-ton cars it is customary to employ a 9-ft. triangle for a system about 200 ft. long; a 10-ft. triangle for a system 200 to 300 ft. in length, etc. These triangles are filled with sand or stone to give the required weight.

In regard to the construction of the curve by the use of ties which project beyond the stringers and carry the rail near their end, as shown in Fig. 5, I would like to say that objection is sometimes made to this method, in which case a platform is constructed of any width desired and the necessary height of rail above this platform is obtained by a long curved block under each rail or by a number of short blocks—the blocks being spiked to the platform.

It will be noted in Fig. 6 that the base of rails should have been shown horizontal instead of inclined. This is evident from the text and from the dimensions given on Fig. 6.

Yours very truly,

Charles J. Steffens.

Guarantee Construction Co., 90 West St., New York City, Feb. 19, 1908.

[We believe that no writer of a technical article should feel that he is unfairly advertising a firm to the detriment of competitors, or that he is making any person or company unduly conspicuous by naming the inventor of the device described. Even after patent rights have expired it seems only justice that the name of the original inventor of a widely useful device should in some way be preserved with the development of the idea and not merely held in the memories of older engineers or in the musty pages of ancient technical papers.—Ed.]

Heat Expansion Stresses in Chimneys.

Sir: I was interested in your comments on Mr. Sanford E. Thompson's report relating to the calculation of temperature stresses in chimneys [Jan. 9, 1908]. I have investigated the problem with some care, and have derived formulas for these stresses applicable to a larger range of cases than the approximate one you suggest.

I assume a uniform temperature gradient, but have not limited the investigation to a thin cylinder for which a straight-line stress curve may be assumed.

Considering any thin ring in the chimney, owing to its definite temperature it would, if free from the influence of adjoining rings, expand a definite amount. But the actual elongation of each ring is fixed by the expansion of the chimney as a whole, and is the same for all of them; consequently the inner hot ones are prevented from expanding the full amount required by temperature, and are therefore subjected to compression. The outer rings are elongated in excess of the amount due to temperature, and therefore are in tension. The actual forces necessary for this are supplied by the normal radial thrusts accompanying the inner compressions.

If the expression for the stress in any one ring be written down, the integral of the expression must be zero, in order that the horizontal forces shall be in equilibrium. This leads to the following equations. Let

$\triangle T$ = temperature difference degrees Fahrenheit,
K = coeff. of expansion,
E = modulus of elasticity, pounds per sqare inch,
R = ratio of external radius ÷ internal radius.

Then the compressive stress on the inner fiber, f_c, is,

$$f_c = E K \triangle T \left\{ 1 - \frac{R-1}{2 \log_e R} \right\} \quad \ldots\ldots\ldots\ldots (1)$$

The tensile stress on outer fiber, f_t, is,

$$f_t = E K \triangle T \left\{ \frac{1 - \frac{1}{R}}{2 \log_e R} \right\} \quad \ldots\ldots\ldots\ldots (2)$$

If R is very nearly unity, both these expressions become

$$\frac{E K \triangle T}{2} \quad \ldots\ldots\ldots\ldots (3)$$

This is the approximate formula you give in your editorial note.

As a matter of theoretical interest the stress in any fiber is given by

$$f = E K \triangle T \left\{ \frac{r_o - r}{r_o - r_c} - \frac{r_o - r_c}{r\, 2 \log_e R} \right\} \quad \ldots\ldots\ldots\ldots (4)$$

where

r_o = external radius.
r_c = internal radius.
r = radius for which stress is required.

It will be noticed that whereas the limiting stresses f_c and f_t depend only upon the ratio of diameters, the value of f depends upon the actual dimensions.

The actual expansion of the chimney is given by

$$x = \frac{K \triangle T (r_o - r_c)}{2 \log_e R} \text{ (in inches)} \quad \ldots\ldots\ldots\ldots (5)$$

The general results may be summarized as follows: The stresses are always less than those by the approximate formula for a thin cylinder; the tension is always greater than the compression; and the neutral fiber is beyond the center fiber of the section.

I append a few numerical results, taking the same data as in your article, viz., $E = 2 \times 10^6$; $K = 6 \times 10^{-6}$; and $\triangle T = 400°$.

$R = \frac{r_o}{r_c}$	f_t	f_c
1.25	2,160	2,100
1.5	2,000	1,800
2.0	1,730	1,340

The figures show that, apart from change in temperature range, the stresses are highest at the top of the chimney. The cases of failure seem to bear this out.

The formulas can be applied to gas-engine cylinders and other similar cases.

The equations give a very curious result for a very thick cylinder, say $R = 8$: viz., a tension on the inner layer, a neutral layer at about one-eighth the thickness, maximum compression at about one-third, a second neutral layer at five-eighths, and the remainder in tension.

Yours truly, Frank H. Hummel.

The University, Birmingham, England, Jan. 25, 1908.

The New British Patent Law and its Relation to Foreign Patents.

Sir: The patents and Designs Act, which came into force in Great Britain on Jan. 1, 1908, in addition to various alterations in the previous acts and in the practice thereunder, introduces some striking innovations, and as some of your readers may be interested in its more important provisions, I venture to outline them as follows:

Working.—At any time not less than four years from the date of a patent, and not less than one year after the passing of this act (Aug. 28, 1907), any person may apply to the Comptroller for the revocation of a patent on the ground that the article or process covered is manufactured or carried on entirely or mainly abroad. This is equivalent to the working clauses in the patent laws of most European countries, which compel patentees to actually manufacture the patented articles in the countries within varying periods (generally three years) from the date of the patent.

The Comptroller may order immediate revocation of the patent, if he is satisfied that there are no good grounds for the non-manufacture; or he may allow a

reasonable time within which manufacture on a commercial scale sufficient to supply the demand in Great Britain must take place, and if manufacture is not commenced within that time, he may then order the patent to be revoked.

Patents of Addition.—These may be obtained for improvements or modifications of inventions covered by a specification on which an application for a patent has been filed, or on which a patent has been granted. They are limited in duration to that of the original patent, and expire therewith. No renewal fees are payable on patents of addition.

Provisional Specifications.—An applicant for a patent having filed two or more provisional specifications for kindred inventions or inventions that are mere improvements on or modifications of those covered by the preceding specification or specifications may file a single complete specification including the subject matter covered by each of the provisional specifications. If the Comptroller is satisfied that the combined subject-matter of all the provisional specifications constitutes a single invention, he may grant a single patent thereon, and such patent shall be dated as of the date of the first provisional specification.

Opposition to Patents.—Three important changes have been made in regard to oppositions to the grant of patents. 1. It permits of opposition on the ground of any complete specification on an application for a patent of prior date whether or not such complete specification has been accepted and published before the date of the patent whose grant is opposed; it also includes specifications filed under the international convention. 2. The grant may be opposed on the ground that the invention or the manner in which it is to be carried out is not fairly or fully described in the complete specification. 3. The Comptroller may award costs in respect of oppositions. He may require oral evidence instead of or in addition to any declarations filed in an opposition.

Revocation of Patents.—The Comptroller may, on an application made within two years of the date of a patent by any person who would have been entitled to oppose the grant of the patent, revoke the patent on the same ground or grounds on which the grant might have been opposed. This practically means that the period of opposition to the grant of a patent is extended to two years. The Comptroller's decision is subject to appeal to the courts.

Search as to Novelty.—In relation to the 50 years' search in the records of British patents, made by the Patent Office Examiners under the Act of 1902, in respect of all complete specifications filed, the Comptroller has (under the new act) the power to refuse the grant of a patent if he considers the invention claimed to have been completely claimed in any prior patent within the 50 years. Under the old act, the most he could do was to insert a specific reference by number and date to such an anticipating patent.

Restoration of Patents—The Comptroller has power to restore any patent which has lapsed owing to the failure of the patentee to pay the renewal fees at the proper time. Any application for restoration, however, is subject to opposition by the public, and the Comptroller's decision is subject to an appeal.

Compulsory Licenses.—Any interested party may petition the Board of Trade for the grant of a compulsory license under a patent, or for the revocation of a patent, on the ground that the reasonable requirements of the public in regard to the supply of the patented articles have not been complied with. If the Board of Trade is satisfied that a case has been made out, the petition shall be referred to the court. The court shall decide either to dismiss the petition, to grant a compulsory license, or to revoke the patent, according to the circumstances of the case.

Contracts for Sale or Licenses of Patented Inventions.—All agreements or contracts for the sale or license of patented inventions shall be void if they contain any condition (A) prohibiting or restricting the purchaser or licensee from using any article supplied or owned by any person other than the seller or licensor; or (B) requiring the purchaser (or licensee) to purchase any articles from the seller (or licensor) or his nominees, and not covered by the patent. Any contract containing such conditions, and made before the passing of the new act may be cancelled by either party giving three months' notice in writing to the other. The party giving notice, however, is liable to pay compensation; this is to be agreed upon by the parties or, failing an agreement, to be settled by an arbitrator appointed by the Board of Trade.

Any contracts relating to the leasing or licensing of a patented article or process, whether made before or after the passing of the act, may (providing the patents have become void) be cancelled by either party by three months' notice in writing. Where such notice is given in respect of a contract made before the passing of the act, the party giving notice is liable to pay compensation to be agreed upon by the parties or to be settled by arbitration.

Marking of Patented Articles.—All patented articles must be marked with the number and year of the patent in addition to the word "Patent" or "Patented"; otherwise a patentee may be unable to recover damages in respect of infringement.

Yours faithfully,

John P. O'Donnell, M. Am. Soc. C. E.

Consulting Engineer and Chartered Patent Agent.

Palace Chambers, Westminster, London, England, Jan. 26, 1908.

The Effect of Alum and Clay in the Waterproofing of Concrete.

Sir: I have noticed with considerable interest the papers appearing recently in your current issues, relating to the permeability of concrete and methods of waterproofing, particularly that of Mr. R. H. Gaines. In the hope that the advisability of using alum and clay may be given additional consideration, I am prompted to present the following:

As is generally known, Portland cement, as made at the present time, liberates, upon the addition of water, more or less free lime, which, uniting with the water, forms a hydrate. It is probably due to the formation and precipitation of this hydrate, together with certain aluminates and silicates, that cement sets and hardens. Ordinary alum being the sulphate of potash and aluminum, the chemical reaction between the lime and alum results in the precipitation of aluminum hydrate and the formation of calcium sulphate and potassium sulphate. These chemical reactions can easily be checked by simply agitating cement in an excess of water, filtering and treating a 2½ or 5% solution of alum with the filtrate. The aluminum hydrate forms as a colloid or gelatinous precipitate and would of course tend to decrease permeability by decreasing the voids. The action of the calcium and potassium sulphate would be such as to increase the early strength of the concrete.

Clays of a plastic nature are those formed by the slow decomposition of rocks containing aluminum and especially feldspar (a silicate of aluminum, sodium and potassium), and naturally besides a mechanical ability in closing the voids in concrete, the silicates of sodium and potassium contained therein, possessed by such clays, would tend toward the formation of calcium silicates, increasing the strength and density of the concrete.

The probable effects of the addition of alum and clay (more especially alum), aside from their temporary effect in reducing permeability or increasing strength, has not been stated in Mr. Gaines' paper, but it is well known to some engineers that the presence of sulphates and alumina in cement is not desirable above certain limitations, owing to their accelerating action on the set, loss in ultimate strength, possible expansion of the sulphates when used in water, and their disintegrating effect in sea-water.

According to my experience in the study of concrete and its application, watertight (not waterproof) concrete can be obtained by the proper selection and use of concrete materials combined with proper care in construction, without the use of any extraneous materials. Further, it is quite probable that waterproof concrete is not desirable from the fact that water is an essential to good concrete; numbers of tests showing that concrete specimens stored where they cannot get water will decrease considerably in strength.

In certain constructions sufficient thickness or richness of concrete to resist the water pressure cannot be permitted and in such instances waterproofing of some nature may have to be done, but the wisdom of using any substance to be incorporated in the concrete, especially if chemically active, should be very carefully considered, for the reason that present day cement is of such high chemical activity that any unbalancing of the chemical equilibrium may result in ultimate disintegration.

Samuel A. Brown.

432 South 50th St., Philadelphia, Pa., Feb. 13, 1908.

The Heaving of Bridge Abutments by Frost in the Ground.

Sir: For the last three years I have had to do with the maintenance of many small railway bridges in Manchuria in a district where the thermometer frequently falls to zero Fahrenheit and occasionally to —10°. The frost makes its appearance about the end of October and continues until nearly the end of March. It causes a railway maintenance engineer considerable trouble owing to the frozen ground lifting bridge piers. The same trouble must be encountered in the United States, but I have never come across any account of it in print and should like to know how it is met and overcome.

Here, in the open country, the ground becomes a solid block to the depth of 3 ft. to 3 ft. 6 ins., but, where shaded from the sun, this is increased to about 5 ft. The footings of our bridges are kept down about this depth (5 ft.) below stream level and yet in very many cases the bridges and the piers are lifted bodily as much as 5 ins. off the piles on which they are founded.

Our standard bridges have spans in the clear of 20 ft., 30 ft., 60 ft., 100 ft. and 200 ft., but only the piers of the 20-ft. and 30-ft. bridges are influenced by frost action. The much heavier weight of the piers of the longer spans prevent them being lifted.

The piers of the 20-ft. and 30-ft. spans are 14 ft. long by 3 ft. 3 ins. and 4 ft. respectively. They rest on one or two footings each about 2 ft. thick and the lower of which caps piles 16 ft. to 24 ft. long, the [illegible] head usually projecting some 6 ins. into the fo[illegible]g. The piers and footing are built of cement concrete.

The first trouble we had was from the [illegible] lifting off the footing in some cases or in other case[illegible] om the pier and top footing coming away together o[illegible] bottom footing.

To prevent this occurring again, as soon as [illegible] ground had thawed out and the pier settled down, [illegible] were drilled on the skew through the sides of the [illegible]s and down through the footings. A 1-in. round or [illegible]e iron bar was put into each hole and grouted up [illegible] neat cement.

The following winter trouble was again experi[illegible]ed, the piers and footings being lifted bodily off t[illegible] piles. Nothing could be done until the spring, exc[illegible]ng, of course, to pack the girders and track level.

In the spring the foundations were dug out [illegible]d that part of the piers below ground or stream be[illegible]nd the footings were encased in a concrete covering [illegible]ving a side and end batter of 1 in 3. This was thou[illegible]t to be almost a sure way of overcoming the difficu[illegible]as it afforded the frozen ground a slope to slide up, but disappointment was in store. The ground grip[illegible] these slopes as tenaciously as it had previously gri[illegible]d the vertical sides of the piers and footings, and again lifted everything off the piles.

This winter the piers which caused trouble have been banked up with sand and soil which is free to expand sideways and upwards, and therefore not likely to grip and lift the piers. It has been found a satisfactory remedy in cases where previously tried, but is at best a troublesome makeshift, requiring the soil to be renewed and removed each year. It may be as well to state here that practically all these bridges span rivers or are flood openings.

By measuring up the surface of concrete exposed to the grip of frozen ground and calculating the weight of the pier, girders, decking, etc., I have tried to find out the relation between the two. It varies very considerably for different piers and this is partly or possibly wholly due to the varying nature of the ground or stream bed surrounding them. Generally speaking, they are surrounded by rubble (about 18 ins.), clay, silt, etc., the whole containing water. In dry ground, with the water level some feet below the surface, there has been no trouble.

My observations seem to show that with such frost as we get here a pier will be safe against lifting if for each ton of weight not more than 2 sq. ft. of pier surface is exposed to frost grip. In other words, the grip and lifting power of 5-ft. depth of frozen ground is less than half a ton to the square foot. With lower temperatures than we get and therefore greater depth of frozen ground, it would probably be more.

In computing the weight on a pier the engine load is ignored, as the piers lift when it is not on the bridge, and its arrival does not cause them to settle again. The exact action of the frozen ground is not clear. By careful levelling I find that the ground between two piers assumes a convex surface as the frost gets into it, the piers remaining at their correct level until some critical point is reached. They then begin to lift and go on doing so until the frozen ground attains its maximum depth.

It would seem that the ground close to the piers becomes frozen to them, grips them and, when first expanding, is able to compress the soil below, while the ground more distant from the piers, finds it easier to rise than to compress the subsoil. Hence the convex surface. At last the ground adjoining the piers has compressed the subsoil to such an extent that it becomes easier for it to expand upward and lift the piers than to go on compressing the subsoil downwards.

A pier for small spans rarely has sufficient weight of itself to allow one ton to each 2 sq. ft. of surface exposed to frozen ground, but resistance to lifting can also be obtained by tying the pier to the footings and the footings to the piles.

In 1906 some piers were built to a design meeting the condition of one ton of resistance to each two sq. ft. of surface exposed to frozen ground. The footings were tied to the piles with iron spikes and the pier tied to the footing with scrap iron rods. The amount of scrap iron and length of spikes can easily be calculated for each job.

These piers gave no trouble in the winter of 1906-7, and piers now being built on an extension have been designed in the same way.

By experiment I found that a 1-inch round iron spike driven into a soft pine pile, previously bored out with a 1-in. auger, attained a grip of 650 lbs. per lineal inch after the pile and spike had been immersed in water for four weeks. The spike would have about the same grip in good concrete, but it is as well to give it a turn over head and thus get a mechanical bond.

I hope that this letter may meet the eyes of some who have had to overcome the lifting power of frost grip on bridge piers, and should be extremely glad to know how they did it. Yours faithfully,

Edwd. H. Rigby.

Tientsin, North China, Dec. 10, 1907.

[We should be pleased to hear from other engineers who have had difficulty with the heaving of bridge piers or abutments from the action of frost against the sides of the piers. That any masonry will be heaved if the frost gets underneath it, is doubtless well known to all engineers of practical experience; but the lifting of masonry foundations by the adhesion of frozen earth at the sides has never before been recorded that we are aware. With a lifting force of 1,000 lbs. per sq. ft., such as our correspondent assumes, many foundations of buildings might be expected to suffer as well as bridge abutments.—Ed.]

The Permanency of Yield of Driven Wells.

Sir: In your editorial comment on the letter entitled "Driven Wells in the Bed of the Ohio River as a Source of Water Supply," in your issue of Feb. 20, 1908, I do not think the following statement is quite fair:

It is also to be noted that such wells are generally of a comparatively limited capacity, and that they often have a very disappointing way of decreasing in yield after being in use a few years.

My criticism would be given best by referring you to a paper which I read before the New England Water Works Association on March 11, 1903. I enclose a copy of the paper, in which I have marked the portion that has reference to the statement quoted.

Yours truly,
George Bowers, City Engineer.

Lowell, Mass., Feb. 24, 1908.

[Perhaps our statement should have been qualified so as to exclude wells constructed and operated as ably as are those at Lowell. The paper which Mr. Bowers encloses was abstracted in our issue of March 19, 1903 (pp. 263-4), and was printed at length, with interesting discussion, in the Journal of the New England Water Works Association for June, 1903 (vol. xvii., No. 2). For the convenience of our readers and because of the importance of the subject we reprint the paragraphs marked by Mr. Bowers, as follows:

A system of wells requires care, as does anything that is expected to produce first-class results. Each well should be provided with a gate by which it may be shut off from the rest, and with a cap so that it may be opened, examined and cleaned. Every well in use should be opened and thoroughly cleaned at least once a year, and the sand and gravel surrounding the openings or strainers should also be cleaned, and the very fine sand removed. When the well is first opened it should be pumped and the yield per minute recorded; it should then be cleaned, as stated, and pumped until the water is perfectly clear. It should then be tested and the yield taken for the yearly record.

After an experience of ten years the speaker believes that when a well is properly made and rightly cared for it will continue (the conditions being the same) to yield its original amount of water, if indeed it does not exceed it.

You should not place much confidence in people who tell you that they once had some very good wells, but that in a few years after they were driven the volume of water decreased so much that they were obliged to abandon them. If this matter were looked into carefully it would be found that the wells were simply left to take care of themselves, or else were not properly pumped. As an illustration of this, a small manufacturing company had a good well; it was 2-in. pipe driven 50 ft., and had a few small holes drilled in the side near the bottom, and the bottom left open. For several years the well supplied all the water needed, but as the company prospered and enlarged its business, more water was required, and the engineer was obliged to pump so much from the well that it gradually drew sand and gravel into it, and instead of getting more water, they got less and less, until they gave the well up entirely. Upon investigation the speaker found that the well would yield 50 gals. per min., but in forcing it beyond its natural capacity and trying to make it a 75-gal. well they ruined it.

Another case has come to the notice of the speaker within a few days. A manufacturing company has a plant consisting of several wells. The company has enlarged its business and must have a greater water supply. On being consulted the speaker suggested that they open their wells and examine them to see if they did not need cleaning. They replied that that would be a very expensive thing to do, as they had built a large storehouse on the land over the wells. They also said that the wells had been giving out for the past few years, and that they did not consider them of much value now, but that they had paid for themselves many times over. This seems poor policy to any one who known the value of good water and the difficulty of obtaining it.

In addition to the valuable suggestions contained in the foregoing quotation, Mr. Bowers pointed out the importance of having the advice of a good geologist in locating wells, before having a good engineer to sink them and connect them up. He also paid a tribute to the able manner in which the Lowell wells are operated by Mr. Robert Thomas, Superintendent of the Lowell water works. We may add that Mr. Bowers was the engineer for the wells during their design and construction.—Ed.]

Work on the Southwest Pass Channel at the Mouth of the Mississippi.

Sir: I have your note of Feb. 5, in which you say:

In our issue of Jan. 9 we published a brief note from information taken, I think, from the New Orleans papers, regarding the practical completion of work at the Southwest Pass. One or two criticisms of our statement as inaccurate have come to us since, and we should be glad to have a statement from you as to just what progress has been made to date in securing deep water through the pass.

You are informed that the jetties themselves have been finished, as planned, and the contract with Messrs. Christie & Lowe was completed Jan. 5, 1908. The jetties are in fine shape, with less settlement thus far than was anticipated would occur. The entire current of the pass is now concentrated through these from shoal water above to deep water at the gulf end, excepting the outflow through the twelve minor bayous between the head of the pass and the jetties.

The dredging of the channel between the jetties has been progressing for nearly three years, and the U. S. Dredge "Benyaurd" is operating principally on the outer bar, and just above, in the lower part of the shoal water above the jetty contraction. A contract with the Bowers Southern Dredging Co. is expected to secure a channel 22,400 ft. long, 500 ft. wide at the bottom, and 35 ft. deep, which should connect the 35-ft. depth above with that between the jetties. On this contract there are now two 20-in. suction dredges, with cutter heads, working the discharge through pipes to the shore, about 1,500 to 1,700 ft. distant. These dredges are at work on the upper 5,000 ft., which is nearly complete, and a part of the second section. There is also a third similar dredge preparing to assist in this work, which should shortly be put to work. The contractors promise to finish by the date of their contract, May 21.

By a recent survey of the channel we know that there is a channel, well defined through the outer bar with a mean low tide depth of 29 ft., and of a practicable width. Above that comes a much deeper portion than is the shoal stretch. The lower part of this is now temporarily shallow, due to the dredging of the upper parts by the contractors, but this is perhaps not to exceed a foot of loose material. On Feb. 8 I sounded the entire channel myself, carefully, and found that from the deep water down through the upper dredged part was the full depth, then the water shaels down to less than 22 ft. for a short distance, then rapidly deepens to the outer bar, which has full depth except for a short portion. There is every reason, therefore, to expect when the next high water comes we shall secure as much depth as now through the South Pass.

The intended depth is, however, 35 ft., and to secure this will require additional depth at the Head of the Passes, where at the present time is not more than 30 ft. But we have not begun to work on this part of the problem.

It has not been stated by this office that the jetty channel is anywhere near completion; in fact, we have made no statements of any kind, but the ship agents are kept posted as to actual facts.

Respectfully, E. H. Ruffner.
Colonel, Corps of Engineers.

New Orleans, La., Feb. 11, 1908.

NOTES AS TO RECENT SURVEYS OF THE SOUTHWEST PASS CHANNEL.

From Dec. 11 to 20 soundings were made of the channel above the jetties with the following general results:

1. Deep water is found in the pass about 2,800 ft. above Burrwood, and for 3,000 ft. the depth gradually decreases from 35 ft. to 30 ft., there being 200 ft. width between the 30-ft. curves.

2. In the next 10,100 ft. the depth decreases from 30 ft. to 25 ft., and the great width of 1,500 ft. between the 25-ft. curves narrows to as little as 400 ft. between the 20-ft. curves.

3. The shoalest part of the channel is now found, through the next 4,200 ft. where from 25 ft. to as little as 22 ft. are found, and 400 ft. width between the 20-ft. curves.

4. In the next 3,100 ft. is a rapid increase to 35-ft. depth, the 25-ft. channel being not less than 250 ft. wide.

5. Then there is a stretch of 7,500 ft. with not less than 35 ft. depth, the 30-ft. channel being not less than 250 ft. wide.

6. From 35 ft. inside to 35 ft. outside is only 700 ft. by the shortest line; the 35-ft. curve on the outside being 1,600 ft. beyond the ends of the jetties.

7. From the 35-ft. channel above the shoal water to the 35-ft. curve beyond the jetties is a distance of 20,400 ft.

8. The outer end of the channel was sounded Jan. 25. Three 20-in. suction dredges are now operating in the shoal water opposite and below Burrwood, to secure a channel 500 ft. wide and 35 ft. deep, and the result of this work is not embodied in the synopsis above.

The U. S. dredge "Benyaurd" and the "General Abbot," are also dredging the shoal water, and these five dredges, and the coming high water with its resultant scour should materially improve existing conditions within the coming three months.

RECORD OF SOUNDINGS DOWN THE CHANNEL LINE OF THE SOUTHWEST PASS, MADE FEB. 8, 1908, BY COLONEL E. H. RUFFNER; SURVEY BOAT "PICKET."

Gage + 1.1. Time.	Depth, ft.	Gage + 1.1. Time.	Depth, ft.
4 p. m.	Began in deep water above the dredges.	4.30 p. m.	24.5
			25
			26
4.07	37	4.40	25
	41		23
	37.5		23
	38		26.5
	37		25
	38		32
4.15	37		35
	Upper dredge anchored.		38
		4.50	42
	Second dredge at work.		43
			49
	37.5		No bottom at 50'.
4.20	36		No bottom at 50'.
	38		38.
	Third dredge at work.		43
			33
	30.5		Outer bar.
	29.5	5 p. m.	30
4.30	32.5		29.5
	32		33
	29		Deep water.
	28		

A Severe Examination for Civil Engineers.

Sir: The enclosed examination paper may interest some of your readers. It was given by the U. S. Civil Service Commission to candidates for the position of Civil Engineer and Superintendent of Construction, at San Francisco early in January. The questions are not given verbatim, but are in substance in agreement with the originals. The weight of the various subjects and the time allowed is given below:

Mathematics	15%	3½ hrs.
Surveying	30%	6 "
Construction	30%	4½ "
Training and experience	25%	— "
Total	100%	14 hrs.

1st Paper—Mathematics.

Take any two. No tables were furnished with this paper.

1. Show in detail how you would obtain the proper dimensions of a retaining wall 8 ft. in height above the level of the ground at the outer toe, which retains earthwork whose angle of repose is 30°, and whose weight is 115 lbs. per cu. ft.; the wall is surcharged to a height of 10 ft. above the top. Assume that the material of the wall weighs 130 lbs. per cu. ft.

2. ABCD is a tract of land whose sides AD and BC are parallel, and 296 and 126 ft. long, respectively. The angle A is 45° and D is 30°. Bisect the area by a line parallel to AD and BC. Show dimensions of one-half to the nearest $\frac{1}{10}$ of a foot.

3. The parallel sides of a regular frustum of a pyramid are hexagons whose sides are 1 and 3 ins., respectively. The height of the frustum is 3 ins. A circular hole, 1½ ins. in diameter, is bored through horizontally from one face to the opposite one; the axis of this hole cuts that of the frustum half way up from the bottom. Draw elevation, plan, and development, with pen and ink, but not necessarily to scale. Find the total exterior surface of the figure, correct to two decimal places.

2d Paper—Surveying.

1. (a) What is the declination, or variation, of the magnetic needle?
(b) Is it constant for a given place?

2. (a) What precautions are necessary to secure accurate results in differential leveling?
(b) Prepare a sample page of notes for profile leveling. Assume B. M. elevations.

3. (a) Name in the order of their accuracy the different methods of measuring horizontal distances.
(b) What corrections are necessary in making stadia measurements?

3d Paper—Surveying.

4. (a) What do you consider the best method for adjusting an engineer's level to bring the line of collimation parallel to the axis of the level tube on the telescope?
(b) Can an engineer's transit be adjusted by this method?

5. Describe in detail the process of establishing the lines and grades for a sewer pipe line.

6. (a) Define a contour line; a profile; a cross section.
(b) Describe three distinct methods used in computing the volume of earthwork.

4th Paper—Building Construction, Specifications, etc.

1. (a) What is a bench mark, and what is it used for?
(b) What is the usual method of obtaining a building line at 90° with a given line, without the use of a transit?

2. (a) Give the proper proportions of good concrete and tell how it shall be prepared.
(b) Requisites of good bbuilding brick and how it shall be laid.

3. (a) How many general types of foundations are you familiar with? Briefly describe each.
(b) What is the difference between sheet piling and bearing piles?

4. Make a detail of a Z-bar column. Show connection at second story to receive steel plate girders, also details of base plate.

5. Make details of four forms of fireproof floor construction.

6. (a) Show arrangement of studding for nailing on surfaces at the junction of two wood partitions at right angles to each other.

(b) Show method of framing the floor around a chimney in a frame building.

7. (a) Make a detail of a king post trussed beam, also of a queen post trussed beam.

(b) Is the king post in a king post truss in compression or in tension?

8. (a) Make a sketch of a range boiler and show its connections.

(b) Briefly describe a long hopper water closet, a short hopper closet, a wash-out closet, and a siphon jet closet.

9. (a) What points should be borne in mind in selecting a heating boiler for a given purpose?

(b) What is the difference between direct-indirect, direct, and indirect radiation?

10. (a) State the current, voltage and candle power of the usual incandescent lamp.

(b) If a test shows excessive leakage, a ground, or a short circuit how would you locate the trouble?

In the mathematics paper the first question requires either the memorizing of complex formulas for the maximum pressure of earth, or their derivation by maxima and minima. The second problem may be solved by ordinary trigonometry, but a maze of figures and arithmetic is the result. Calculus offers a reasonably easy method for obtaining the general formula for the area. The third requires a knowledge of geometry and projections. Since two problems were to be selected, a candidate must be sharp in his mathematics and know calculus in order to receive a high rating in this.

In the paper on surveying all the six problems were to be done. Though a few of them are simple, the six as a whole form a group covering the whole field thoroughly. To obtain a high rating the candidate must not only know the subject theoretically, but must know the practical kinky-kinks that come from long experience.

The construction paper takes one's breath away at first sight. While the questions are elementary and broad, they cover a wide range of ground—framing, concrete, heating, electricity.

In "Training and Experience" the requirements were, according to the circular, "a good scientific education, some practical experience in . . . construction of roads, laying out of grounds, sewer and water lines, concrete walks, etc., and especially in building construction." This practically means a technical degree plus several years, at least, of experience.

The examination, as a whole, presupposes a well-trained, all-round civil engineer of several years' experience. The salary offered is $1,500 per year.

"B. Civil."

San Francisco, Jan. 10, 1908.

Notes and Queries.

C. F. B. wishes to know whether there is available an automatic siphon for use at the end of tidal sewer outlets and to be discharged by incoming or outgoing tides.

The date of change from private to public ownership of the water-works of Portland, Ore., as given in our issue of Feb. 6, should have been 1895 instead of 1905.

J. M. L., Farmville, Va., writes:

Will you please explain to what the white deposit which forms on cement work is due? It is especially noticeable on concrete block used as retaining wall. How may it be prevented?

This deposit, known as efflorescence, is due to some of the soluble lime and magnesia salts of the cement leaching through the mass to the surface. It may be due to a number of causes, among which may be mentioned a poor cement heavy in soluble salts; second, the too free use of water in mixing so that the mass has not time to dry out, and third, the placing of new concrete on old without cleaning the old surface of the scum that always collects. In time such discolorations will generally be dissolved by the rain and washed away. However, if they must be immediately removed either a dilute acid or a wire brush scrubbing treatment must be resorted to. With good cement and care in placing and cleaning old surfaces, efflorescence may be reduced to a minimum. See Eng. News, Dec. 22, 1904, p. 576.

A FREIGHT DIVERSION RAILWAY or cut-off is being built by the Illinois Central Ry. to relieve the city lines and terminals of Memphis, Tenn., from the heavy through freight traffic. The new line is a little over 16 miles in length, and is termed the Memphis & State Line Ry. Leaving the main line at Woodstock it runs south for seven miles to a line of the Louisville & Nashville Ry. at Leewood, and over this line for about two miles to Anlon. Another portion of the new line extends seven miles southwest from this point to the Nonconnah freight yards of the Illinois Central Ry., south of Memphis. The railway has maximum grades of 0.5%, the sharpest curves are of 2°, and there is a double track throughout. The structures include several plate-girder bridges, some with solid floor construction, and there is a double-track, ballasted-floor trestle approach to the Wolf River bridge.

TYPES OF RAPID-TRANSIT CAR FOR MAXIMUM SERVICE.

A very interesting investigation has been in progress for some months in New York City. The municipal rapid transit subway, which less than four years ago added fully 100% to the city's existing rapid transit facilities, is heavily overloaded during the morning and evening rush hours. Not only is an intolerable degree of crowding produced, but the crowding reacts on the traffic capacity of the system, so that when the supply of passengers is greatest the supply of trains is considerably less than the maximum. The Public Service Commission, instituted by the State to control the operation of all public-service enterprises in the city, has grappled with the problem of determining whether and how these conditions may be ameliorated. Mr. Bion J. Arnold was retained by the Commission to study the matter. One or two interim reports have already resulted from this study, and now he has rendered an exhaustive report on types of cars and their relation to traffic capacity.

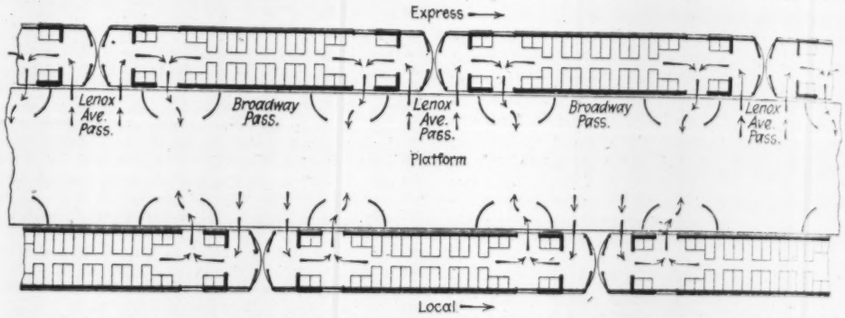
To appreciate the importance of this matter to urban rapid-transit service, two facts must be understood, both of which are rather obvious on reflection: Firstly, rapid transit lines constantly increase their peak load, that is, the amount and concentration of their rush-hour traffic. They serve to make a larger and more remote territory available for residence, and consequently they tend to increase the number of people dependent upon the rapid-transit service for the daily trips between home and business. As a result, on every such line the problem of handling the peak load becomes more important every day, and most lines sooner or later are compelled to use every possible means to increase their rush-hour capacity.

Secondly, the time lost by trains at stations, while passengers leave and enter the cars, is the principal factor in determining the traffic capacity. Safety of operation requires a certain time to elapse between one train's starting from a station and the following train's pulling in and coming to a stop at the same station. This interval, plus the time spent in the station-stop, gives the time-spacing or "headway" of trains and therefore determines the number of trains per hour which can run on a single track. To increase the capacity of the line, either the trains must be lengthened or the "headway" of trains must be decreased. The former is generally impossible, as the maximum length of train is fixed by length of station platforms, motive power or other fixed conditions. The only way left to increase capacity is to run trains on a shorter headway, by cutting down the station stop.

In the New York subway, the fixed arrangement of the station platforms limits the length of trains on the two "express" tracks to eight cars, and on the two "local" tracks to five cars; the front door of the forward car and the rear door of the rear car are not accessible at the platforms. Exceedingly difficult and expensive reconstruction would be required to lengthen the station platforms. The operating com[pany], the Interborough Rapid Transit Co., has a [suf]ficient number of cars to run longer trains [or] more frequent trains, than can be run at pre[sent]. The problem, therefore, is to reduce the [stop] of trains at stations so that more frequent [ac]cession of trains will be possible. This is [the] problem which Mr. Arnold deals with.

The length of time a train must [stop] at a station depends on the number of [pas]sengers leaving and entering, and on the rapidity of this traffic interchange. Obviously, anything that hampers or delays the traffic interchange will increase the length of stop. For example, when a train is very crowded, with the aisles full of standing passengers, the movement of passengers leaving and entering is necessarily slower than at other times. Also, narrow or inconveniently placed car doors retard the traffic interchange and therefore delay the train. Clearly, then, the arrangement of doors and seats in the car has an important bearing on the question of increasing the capacity.

The present subway cars are 51 ft. 2 ins. long over all, and 8 ft. 7 ins. wide; they have 52 seats, of which 16 are in the form of two-seat cross benches on either side at the center of the car, while the remaining 36 are in longitudinal benches along the sides of the car. Each car



TYPE OF CAR AND ARRANGEMENT OF STATION RAILINGS RECOMMENDED FOR NEW YORK SUBWAY.

Car similar to that now in use, with addition of another door near the end door. The arrows show the direction of movement of leaving and entering passengers.

The car shown, with 16 two-seat cross benches, is the type recommended for the future cars to be built for the present subway. For the alteration of the cars now in use, the same form with but eight cross-benches is recommended. This leaves the seats as they are in the present cars, except for the loss of eight seats of the longitudinal benches, two at each added door.

has four sliding doors, one at either side of either end platform. In the first lot of cars built for the subway these doors were made 29 ins. wide, but their insufficiency became quickly apparent and in all subsequent cars the doors were made 38¾ ins. wide. The company now has 500 composite wood-and-metal cars and 300 all-metal cars; 50 more of the latter type have been ordered, and are being delivered.

The train schedule of the company contemplates the operation of 30 trains per hour on both express and local tracks during the rush hours. This means a "headway" of 2 mins. Four or five months ago Mr. Arnold found that only 27 express trains per hour passed the Grand Central station during the rush hours. The average* station stop at about this time was 65 sec. Since then, by strong efforts on the part of the management, and with the aid of a special force of platform guards, the average station stop has been reduced to 55 sec., and the hourly number of rush-hour express trains has been increased to 30 "on most days." This number, 30, provides 12,480 seats per hour on the express tracks and 7,800 seats per hour on the local tracks, but

there are times when three times as many passengers are carried on some express cars as there are seats.

Since the Brooklyn extension of the subway, via the Battery tunnel, was opened, a schedule calling for 40 express trains per hour has been instituted for that part of the system lying south of 96th St. It has not been possible to live up to this schedule.

Mr. Arnold finds that at present the average

*The average length of stop is not the only determining factor, as a lagging train generally makes abnormally long stops and it is just these trains that cause congestion, by delaying the trains behind.

express station stop (55 sec.) is made up as follows:

Opening doors	2 sec.
Unloading 163 passengers by 14 doors, 15-50 sec., average	20 sec.
Loading 206 passengers by 14 doors, 15-30 sec., average	20 sec.
Closing doors and giving bell-rope signal to start	13 sec.

He believes that the last item can be reduced by 5 sec. by using pneumatic door-handling devices and an electric signal to notify the motorman automatically when all doors are closed. The two large items, discharging and taking on passengers, aggregating 40 sec., can be cut in half, he believes, by using a type of car permitting more rapid traffic interchange.

Two types of car have been widely advocated as a substitute for the present subway car: (1) Cars with a central side door in addition to the end side doors, such as have been adopted for the Hudson tunnel system of the Hudson & Manhattan R. R. Co., and (2) cars of the Illinois Central type, with cross seats, two side aisles and a large number of side doors, giving practically direct exit from any point of the car. Mr. Arnold enters into a thorough discussion of both these types and also of three new types, apparently devised in the course of the investigation.

Briefly summarizing his arguments, we may note that he finds two objections to both types of car mentioned. There would be serious difficulty in operating them on account of the numerous curved station platforms. Of the stations served by express trains, four have curved platforms: South Ferry, Brooklyn Bridge, 14th St., and 177th St.; the first has a radius of platform edge of 191 ft., and there is a space 24 ins. wide between center of car and edge of platform, while the others have radii of 410 to 485 ft., which give spaces of 12 ins. to 10 ins. It is a fact that on the convex edge of the platform the present end doors face the same widths of gap (at South Ferry loop there is only a concave edge), but the presence of the car and station guards enables a warning of this to be given to passengers. It is thought that with either a center door or multiple side doors it would be necessary to introduce sliding platforms to bridge these gaps, which Mr. Arnold estimates to cost $2,000,000!

The second objection to the center-door car is that it would probably prove impossible to enforce the principle upon which this type of car is designed to be operated, namely, compelling passengers to leave by the center door and enter by the end doors, or vice versa. In the Boston subway it has been found impossible. In the Hudson tunnels, and in the shuttle-train service on the Brooklyn Bridge, the terminal stations have separate platforms for departing and entering passengers, so that the three-door system may be employed to its full value. But when it is not possible to maintain such circulation, the center door is useful merely by adding door space. Mr. Arnold holds that this additional door space may be provided in more useful fashion by locating doors elsewhere than at end and center.

The same objection does not apply to the Illinois Central car, since this does not rely on circulation, but on maximum amount of door space. The difficulty with this type, aside from the trouble at curved platforms, is that there would be much delay in closing the doors because it would not be possible to have a station guard at every door to assist in cutting off the tide of entering passengers. The conclusion is that on this account the additional door space would fail to realize the reduced length of station stop which is sought after.

A further objection to both types of car is that the station platforms do not serve the full length of the front and rear car, and would have to be lengthened to serve the center doors or the multiple side doors of these two cars.

The various designs of car which Mr. Arnold presents and analyzes in his report are listed below. The drawings shown in the report need not be reproduced here, except for the plan of the recommended design, the one which is found to be best adapted for use in the subway by alteration of the existing cars. In general, it is considered necessary to have pneumatic door-operating devices and automatic starting signals on all cars of any one of the types described.

I. CARS WITH END AND CENTER DOORS.—End doors 38¾ ins. wide, center door 50¼ ins. wide. The center door would be operated from one end by a connection with the end door.

1. Car with longitudinal seats only; 44 seats. Aisle 52 ins. wide. Seats 21 ins. deep, 19 ins. wide.

2. Car with back-to-back cross seats and two side aisles; 46 seats. The seat benches are 56 ins. long, 18 ins. deep, and 18 ins. apart in the clear. The side aisles are 19 ins. wide each; cross aisle at middle of car 48 ins. wide.

3. Car with reversible cross seats and two side aisles; 42 seats. The seat benches are 56 ins. long, 18 ins. deep, and 11 ins. apart from back to front. Side aisles 19 ins. wide. Increasing the spacing of seats to make middle of bench better accessible reduces the number of seats to 36.

4. Car with reversible cross seats and a central aisle; 52 seats. Benches 37½ ins. long, 18 ins. deep, spaced 11 ins. back to front. Aisle 19 ins. wide. There are three longitudinal seats on either side at each end of the car, which with the end platforms gives a large standing space. The clear space at the middle of the car is about 72 ins. wide parallel to the length of the car.

II. CARS WITH TWO SIDE DOORS NEAR THE QUARTER POINTS.—Each door is a two-leaf sliding door of 68 ins. total width and 4-in. center post, or 64 ins. clear opening. Doors 19 ft. 4 ins. apart in the clear.

5. Car with longitudinal seats only; 44 seats. Aisle 52 ins. wide. Seats 21 ins. deep, 19 ins. wide. Seat banks extend out into car platform to end wall.

6. Car with longitudinal seats in middle section, fixed cross seats in end sections; 48 seats. Aisle in middle portion 52 ins. wide, in end portions (central aisle) 19 ins. wide.

III. CARS WITH THREE SIDE DOORS.

7. Car with longitudinal seats only; 44 seats. Middle door 50¼ ins. (single-leaf). Outer doors 38¾ ins. each (single-leaf). Each outer door is 11 ft. 2½ ins. in the clear from middle door.

8. Car with cross and longitudinal seats; 48 seats. To provide a number of cross seats in each end, the outer doors are moved closer to the middle door and the middle door is made much larger to improve the circulation. Middle door 90 ins. wide with 10-in. center post, or 80 ins. clear opening (two-leaf). Outer doors 40 ins. wide each, 4 ft. 6 ins. in the clear from middle door. Eight longitudinal seats. Ends beyond outer doors are filled with fixed cross seats with 19 in. central aisle.

IV. CARS WITH MANY SIDE DOORS.

9. Car with three doors intermediate between present doors, and cross seats with side aisles; 48 seats. The end doors are the present 38¾-in. doors, the others are 42 ins. and 48 ins. (middle door). The side aisles are 19 ins. each, the back-to-back seat benches 56 ins. long, 18 ins. deep, and 24 ins. apart.

V. CARS WITH TWO DOORS NEAR EACH END.

10. Car with present arrangement of seats except for loss of two longitudinal seats at each added door; 44 seats. The extra doors are 38¾ ins. wide, and are 46¼ ins. from the end doors. Both doors slide into the same pocket. The aisle between the longitudinal seats is 52 ins. wide, while the central aisle between the 8 two-seat cross benches at the middle of the car is 19 ins. wide. This is the type recommended as best for the present, the cars now in use to be altered to suit.

11. Car same as the preceding with eight additional cross-benches; 48 seats. The doors and aisles are the same as for car 10. This type is recommended as the best for future cars for the present subway. It is shown in the plan herewith.

The report shows also three designs of car for future subways, where increased capacity is gained by making the cars 18 ins. wider (9 ft. 4 ins. inside instead of 7 ft. 10 ins.). One of these is a car with 8 side doors, and fixed back-to-back cross seats with 20-in. central aisle, seating 80. Another is a car modeled closely on the Illinois Central car, with eight 25-in. side doors and back-to-back cross seats with 19½-in. side aisles, which seats 68. The third is a car of the double end-door type in which the space between doors is occupied by fixed cross seats with a 20-in. aisle off center, so that the benches on one side seat 3 while the other benches seat 2. The doors in this car are made 48 ins. wide. The car seats 62. However, this third car is 56 ft. 6 ins. long over all, as compared with 51 ft. and 51 ft. 6 ins. for the other two.

A system of guide railings on the station platforms is recommended for use with the type of car found most desirable for present use [numbered 10 in our list]. These railings, as well as a group of cars of this type, are shown in the accompanying plan of an express station.

It is noteworthy that the report dwells at much length on the Illinois Central type of car, either because of its inherent merits or because of the strong advocacy given this car in other quarters. While the findings are against the multiple-door car for use in the present subway, this is largely due to the fact that it is impossible to make certain changes in station arrangement which would be essential to success in operation. These are: (a) Elimination of curved station-platforms; (b) provision of separate station-platforms for passengers leaving trains and passengers entering trains. This would largely reduce the crush, by separating the conflicting tides of traffic; (c) provision of "waiting" spaces or platforms separate from the platform from which the passengers board the trains, and gates between the two so that the passengers entering a station to take a train can be held back from the "boarding" platforms when the latter are sufficiently filled. This would not in itself reduce the crush, but would transfer it from the doors of the train to the gates at the entrance of the "boarding" platform, where it would not act to delay the movement of trains.

The report does not state in so many words that, with these improvements, the Illinois Central car would be the best, but it implies at least that this car would then be practically as good as any.

Another conclusion that is not specifically enunciated, and one which is beyond the scope of the report, perhaps, is the following: In any rapid-transit line destined to serve a heavily congested traffic, the three improvements mentioned are absolutely essential requisites to efficient operation. It is clearly evident that any future rapid-transit lines, especially underground lines, can be regarded as properly designed only when they include the three elements mentioned.

ACETYLENE GENERATORS have, until recently, been required by rules of The National Board of Fire Underwriters to be installed and operated outside of insured buildings. Under amended rules this apparatus is now permitted inside such buildings even in closely built-up districts. This action was taken by the executive committee of the National Board on Jan. 30, after considering the reports of several committees. While acetylene generators are now permitted inside insured buildings, the preferred arrangement is still for the installation and use outside.

STEAM SHOVEL RECORDS ON THE ISTHMUS were broken at the Culebra cut on Feb. 10, 1908. The "Canal Record" of Feb. 19, says:

The total amount of material removed was 50,784 cu. yds. with 46 shovels, an average of 1,104 cu. yds. per shovel for the eight-hour working day. This material was loaded on 1,584 Lidgerwood flats, 1,199 Western dump cars (small) and 262 Western dump cars (large), and hauled an average distance of about ten miles. Three hundred and fifty-two trains were handled by 134 locomotives, divided as follows:

Serving steam shovels	88
Switching	10
In use with spreaders	8
" " " Lidgerwood unloaders	10
" " " track shifters	3
" " " labor trains	3
" " coaling shovels	2
" " " work trains	10
Total	134

ADJUSTABLE AND PORTABLE FORMS FOR CONCRETE BUILDING CONSTRUCTION.

The cost of form work and centering forms a large proportion of the total cost of concrete building construction, as every engineer and contractor engaged in such work well knows. Many systems for using forms over and over again are in use and have been shown in these columns. We show herewith a system of this sort which has been recently used in Chicago.

The principle of the design is clearly shown in the drawings, Figs. 1 and 2. The posts are telescopic, with a 4 × 4 in. stick for the lower section and two sticks, 2 × 4 ins. for the upper sections. Holes through the sticks allow of adjusting the height, and the parts are secured by bolts and clamps. The posts are set up by wedges beneath them. Diagonal bracing (not shown on the drawing) can be attached as required. Cross pieces at the top of the posts support the girder forms, which are also telescopic; the sides and bottom of the girder forms are racks with alternate bars secured to separate sticks so that the form can be shortened or lengthened by sliding the racks in or out. The cross pieces or caps on the posts support telescopic joists built in the same way as the posts, and these are further supported by intermediate posts. Upon the joists are laid sectional racks forming the support for the floor slab. All the forms are lined and covered with galvanized sheet iron pressed to shape, and flat sheets of the same material cover the centering for the floor slabs.

The column forms, Fig. 3, are composed of four lengths of galvanized iron, with the vertical edges flanged and fitted between timbers which give the necessary stiffness and are bolted together. The size of the column may be varied by inserting filler strips between the flanges, as shown. All the sectional parts of the timber work are put together with bolts, so that the centering can easily be erected, taken down and packed for transportation. The metal troughs and sheets are also easily portable. No concrete is laid against the wooden framing, and the metal facing of the forms gives a smooth finish to the concrete. The centering can be erected and removed by laborers, thus practically dispensing with carpenter work.

Fig. 4 is a view showing the placing of the centering for one of the floors of a building for the Eddy Foundry Co., in East Ohio St., Chicago. The telescopic racks are in place to support the metal sheathing and the girder forms are already in place.

This system of centering for concrete work is the invention of Mr. L. G. Hallberg, and is being introduced by Mr. G. D. Rankin, 84 La Salle St., Chicago, to whom we are indebted for drawings and information.

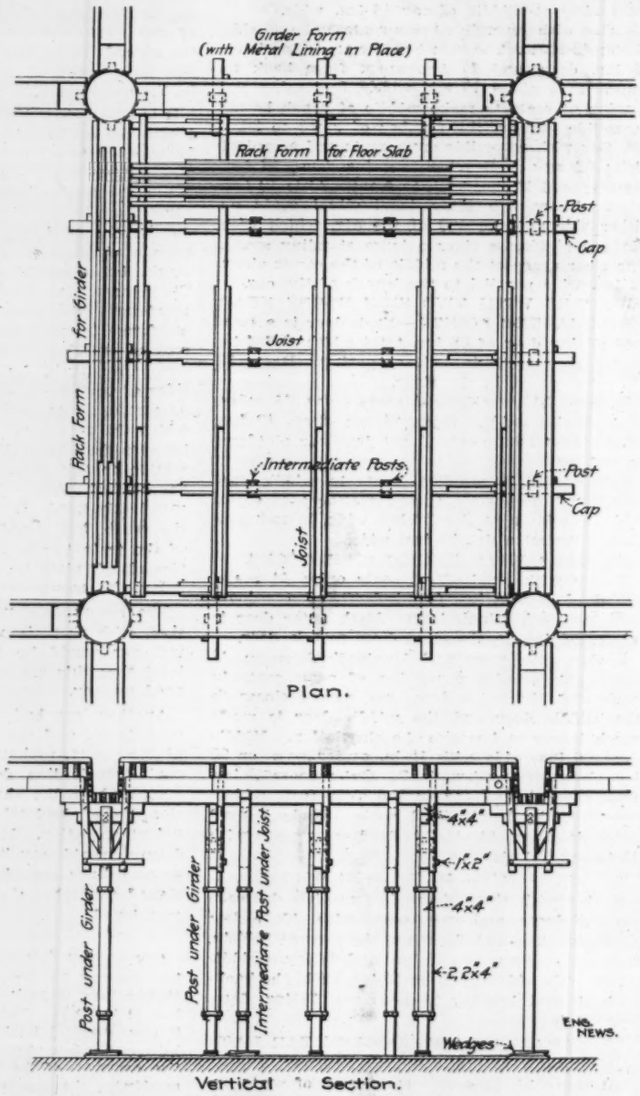


FIG. 1. ADJUSTABLE AND PORTABLE CENTERING FOR CONCRETE BUILDING CONSTRUCTION.

A DIAGRAM OF HIGH FINANCE.

Of all the complicated tangles of corporate relationships woven by the manipulators of high finance during the past decade, the most labyrinthine is that covering the passenger traffic railways in New York City. In our issue of Oct. 3 last we expressed a plain opinion of this evil web and of the human spiders who have woven it. It was fabricated without doubt for no other purpose than to defraud the public and the innocent holders of street railway stocks and bonds.

Recently the Public Service Commission of New York City, through its Counsel, Mr. Wm. M. Ivins, has succeeded in presenting in a comprehensible form the relations between the various companies which are merged in the Interborough-Metropolitan Co. by utilizing the diagram plan. We have frequently called attention to the advantages of the diagram system in making clear the relations between different parts of an organization; but we have never seen it applied to better advantage than in the present case. Of course for details of the exact relationships of the several companies to one another, reference must needs be made to such publications as "Poor's Manual."

It may be explained that the dotted lines by which the Third Ave. system is connected to the Metropolitan Co. is used to indicate the fact that the Third Ave. system is now in the hands of a separate receiver.

It will be noted that the companies in the diagram include all the street railway lines, surface, overhead and underground, in the Borough of Manhattan, New York City, besides most of the lines in the Bronx Borough and a considerable mileage on Long Island. There is no doubt that the system is by far the greatest and most profitable aggregation of city passenger railways in the world. The diagram gives a graphic record of the manner in which the system has been loaded down with stock issues and with bond issues until the burden became too great for even the enormous revenues of the system to support.

It is particularly fashionable just now to decry Government interference with or regulation of corporations, and much of the argument presented on that side have a fair semblance of truth. The history of the New York City railways, however, shows the result of leaving corporation manipulators to pursue their work without supervision by some public authority. It is clear that Government supervision is absolutely necessary to protect the investor from robbery, as well as to secure good service and reasonable rates for the public.

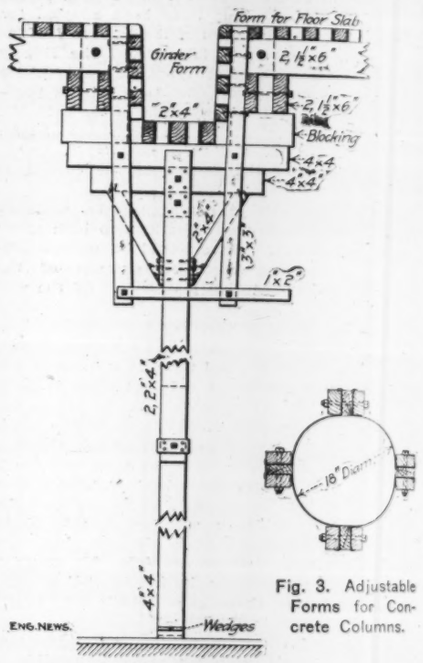


Fig. 3. Adjustable Forms for Concrete Columns.

Fig. 2. Details of Post and Form for Girder.

A COAL MINE EXPLOSION in the La Rosita mine near San Juan de Sabinas, Mexico, on Feb. 27, caused the death of at least 75 Mexican and Japanese laborers. About 200 men were in the mine at the time of the explosion.

AN EXPLOSION IN A SULPHUR GRINDING MILL completely destroyed the factory of the National Sulphur Works in Williamsburg, New York City, on Feb. 29, and so injured three of the workmen that they are not expected to survive the accident.

THE FOURTH CAR BARN FIRE in New York City within a year destroyed, on the night of Feb. 29, the barn of the New York City Railway at 96th St. and Second Ave., with the loss of about 700 cars and a large amount of other equipment. The total money loss will run up close to $2,000,000. The building was used both for storage and, on the upper floors, for repair and paint shops. It was in these upper stories that the fire started and the oil and varnish fed the flames to such an extent that the firemen could not save the building or its contents. Since March 4, 1906, there have been six serious car barn fires in the properties held by the New York City Ry. On the same night as this latest fire a large paint factory only five blocks away was destroyed by fire with a loss of about $125,000.

THE BOYERTOWN, PA., FIRE, at which 169 persons lost their lives on the evening of Jan. 13, 1908 (Eng.

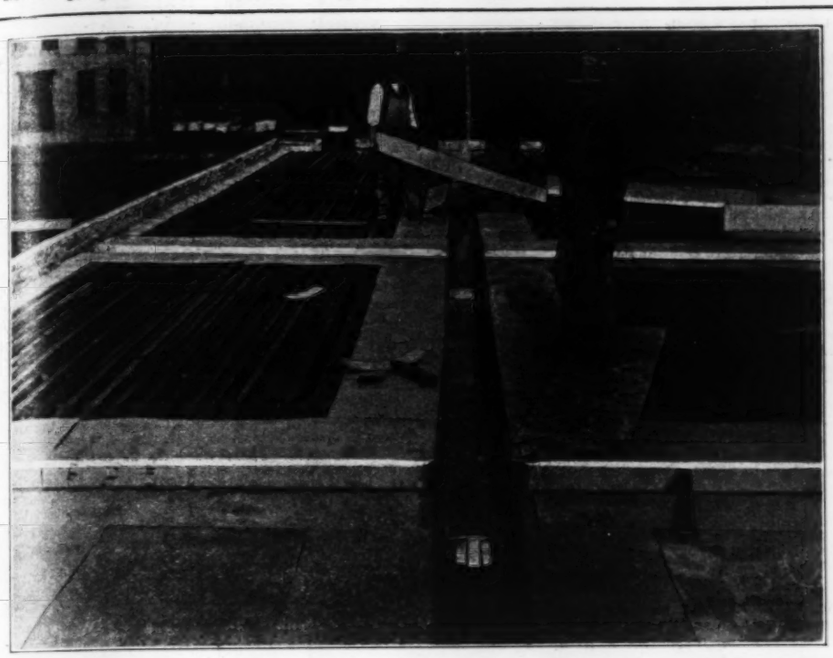


FIG. 4. FLOOR AND GIRDER FORMS, WITH PART OF GALVANIZED SHEET METAL LINING IN PLACE.

News, Jan. 16, 1908), has been reported on by the Coroner as follows:

We find the primary causes [of the fire] to have been the employment by Mrs. Harriet E. Monroe of an inexperienced and incompetent operator of the calcium light in the person of Henry Fisher, and the laxity of the Deputy Factory Inspector of this district and the Department of Factory Inspection of the State of Pennsylvania in its failure to enforce proper and adequate fire-escapes and fire appliances, as well as its failure to enforce existing laws insuring public safety.

We request the prosecuting attorney of Berks County to arrest, and if possible convict, Mrs. Harriet E. Monroe and Harry McC. Bechtel, the deputy factory inspector of this district, on the charge of criminal negligence.

We recommend the enactment of laws as follows:

First. Creating departments of public safety and buildings, whose province shall be to provide for means and appliances to insure public safety in the boroughs of this Commonwealth.

Second. Requiring that all operators of lights used in stereopticon and moving picture machines be obliged to undergo an examination, and if found competent, certificates be issued to them by the Department of Factory Inspection.

After carefully considering the degree of guilt attaching to the two persons accused by the jury the prosecuting attorney decided that it would be impossible to procure a verdict of guilty against them and therefore no indictments have been brought in.

PANAMA CANAL EXCAVATION during February reached the record figure of 2,945,880 cu. yds. for 25 working days, or 122,745 cu. yds. per day, as against 2,712,568 cu. yds. for 26 days in January, or 104,330 cu. yds. per day. Detailed figures will not be available until next week's issue.

THE WATER SUPPLY AND SEWERAGE SYSTEMS in the Panama Canal zone were briefly reviewed in a paper on the plumbing and sanitary work of the canal buildings which was presented at the recent Chicago meeting of the American Society of Plumbing Inspectors and Sanitary Engineers. This paper was written by Mr. C. L. Stockelberg, Superintendent of Plumbing on the Canal Zone, and from it we take the following information: The division of Municipal Engineering, of which Mr. J. G. Holcombe is Division Engineer, was organized in July, 1904, for the purpose of constructing sanitary systems and water-works and sewers in the cities of Panama and Colon. Within a few months, however, the necessity for similar work in the Zone developed. This has resulted in the placing of 43 miles of water pipe and 29 miles of sewer pipe of various sizes in the territory controlled by the United States. In the city of Panama, 11 miles of water pipe and 17 miles of sewer pipe have been laid, 1,843 house connections have been placed and 134 fire hydrants have been installed. In Colon, 5 miles of water pipe and 5 miles of sewer pipe have been laid, 54 hydrants have been installed, and 849 house connections made. The city of Panama is supplied through a 16-in. main from the Rio Grande reservoir, which, until recently, had a capacity of 396,000,000 gals. This has been increased to 521,000,000 gals. The Camacho reservoir, which supplies the district from Empire to Bas Obispo, inclusive, has a capacity of 256,000,000 gals. The reservoir for supplying Gorgona, Matachin, Juan Grande, and Mamei has a capacity of 85,000,000 gals. The Brazos Brook reservoir, upon which Colon and Cristobal depend for their water, contains 548,000,000 gals. Filter plants, with a daily capacity of 1,500,000 gals. each, are in operation on the Panama and Colon systems.

THE TYPHOID DEATH RATE OF CHICAGO in 1907 was 17.80 per 100,000 population, against an average of 27.5 for the 10 years 1897 to 1906, inclusive. The actual number of deaths in 1907 was 376, compared with 370 in 1906.

THE U. S. SCOUT CRUISER "CHESTER" developed in her trial run on Feb. 28 the uncorrected speed of 26.21 knots per hour over a mile course. She made seventeen runs over this course, and it is expected that a mean of the highest five, when corrected, will show a speed of 25 knots per hour, or one knot per hour in excess of the contract requirements.

TWO PENNSYLVANIA R. R. EAST RIVER TUNNELS at New York City have been holed through. There are four single-track tunnels in the group, connecting with two double-track tunnels which extend under 32d and 33d Sts. from the new terminal station at Seventh Ave. east-

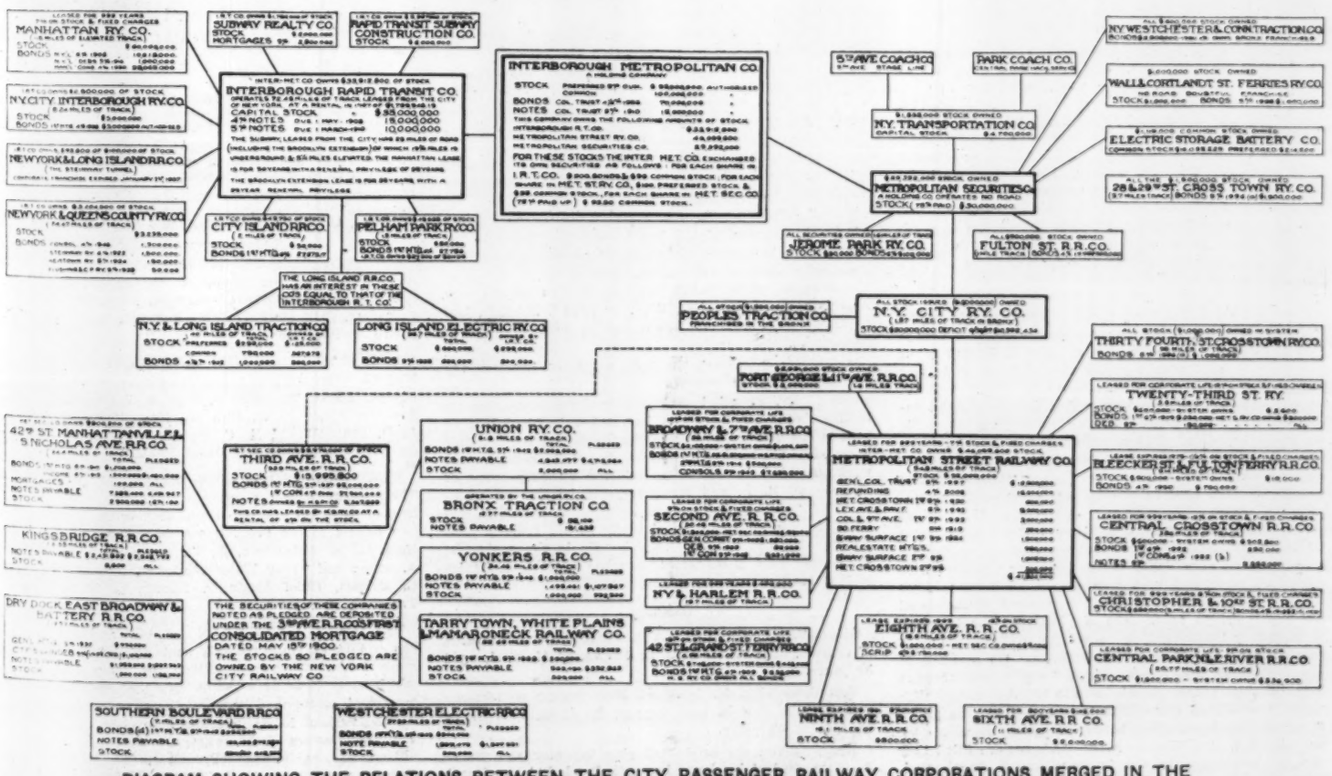

MANHATTAN RY. CO.
SUBWAY REALTY CO.
RAPID TRANSIT SUBWAY CONSTRUCTION CO.
INTERBOROUGH METROPOLITAN CO.
INTERBOROUGH RAPID TRANSIT CO.
N.Y. CITY INTERBOROUGH RY. CO.
NEW YORK & LONG ISLAND R.R. CO.
NEW YORK & QUEENS COUNTY RY. CO.
CITY ISLAND R.R. CO.
PELHAM PARK RY. CO.
THE LONG ISLAND R.R. CO. HAS AN INTEREST IN THESE COS EQUAL TO THAT OF THE INTERBOROUGH R. T. CO.
N.Y. & LONG ISLAND TRACTION CO.
LONG ISLAND ELECTRIC RY. CO.
5TH AVE. COACH CO.
PARK COACH CO.
N.Y. TRANSPORTATION CO.
METROPOLITAN SECURITIES CO.
JEROME PARK RY. CO.
FULTON ST. R.R. CO.
N.Y. WESTCHESTER & CONTRACTION CO.
WALL & CORTLANDT ST. FERRIES RY. CO.
ELECTRIC STORAGE BATTERY CO.
28TH & 29TH ST. CROSS TOWN RY. CO.
PEOPLES TRACTION CO.
N.Y. CITY RY. CO.
PORT GEORGE LI. AVE. R.R. CO.
THIRTY FOURTH ST. CROSSTOWN RY. CO.
TWENTY-THIRD ST. RY.
42D ST. MANHAT. TANVILLE & ST. NICHOLAS AVE. R.R. CO.
THIRD AVE. R.R. CO.
UNION RY. CO.
BRONX TRACTION CO.
YONKERS R.R. CO.
KINGSBRIDGE R.R. CO.
DRY DOCK, EAST BROADWAY & BATTERY R.R. CO.
THE SECURITIES OF THESE COMPANIES NOTED AS PLEDGED ARE DEPOSITED UNDER THE 3RD AVE. R.R. CO. FIRST CONSOLIDATED MORTGAGE DATED MAY 15TH 1900. THE STOCKS SO PLEDGED ARE OWNED BY THE NEW YORK CITY RAILWAY CO.
TARRYTOWN, WHITE PLAINS & MAMARONECK RAILWAY CO.
BROADWAY & 7TH AVE. R.R. CO.
SECOND AVE. R.R. CO.
NY & HARLEM R.R. CO.
42ND & GRAND ST. FERRY R.R. CO.
METROPOLITAN STREET RAILWAY CO.
EIGHTH AVE. R.R. CO.
NINTH AVE. R.R. CO.
SIXTH AVE. R.R. CO.
BLEECKER ST. & FULTON FERRY R.R. CO.
CENTRAL CROSSTOWN R.R. CO.
CHRISTOPHER & 10TH ST. R.R. CO.
CENTRAL PARK, N. & E. RIVER R.R. CO.
SOUTHERN BOULEVARD R.R. CO.
WESTCHESTER ELECTRIC R.R. CO.

DIAGRAM SHOWING THE RELATIONS BETWEEN THE CITY PASSENGER RAILWAY CORPORATIONS MERGED IN THE INTERBOROUGH-METROPOLITAN CO.

(Compiled for the Public Service Commission of New York, First District, Feb. 1, 1908.)

ward to the East River. All four tunnels were attacked from both ends, with duplicate shield and compressed-air plants. The headings of one of the four tunnels were joined on Feb. 21, and on March 3 a second tunnel was holed through. Another tunnel is very near junction, but the fourth will require several months more before the meeting of shields.

THE BITTER ROOT TUNNEL of the Chicago, Milwaukee & St. Paul Pacific coast extension is being hurried as fast as possible, in order that it may not delay the opening of the line. Tracklaying has been going on at the east end of the line and some has been done at the west end. The completion of the 8,500-ft. tunnel is expected in the early part of 1909.

DYNAMITING OF BRIDGES and bridge construction plants has been rather frequent of late in the neighborhood of Cleveland, Ohio. On Feb. 5, about noon, dynamite was exploded by unknown parties under the falsework of a new bridge being built over the Baltimore & Ohio R. R. tracks at Eagle St., but fortunately little damage was done. Three other explosions occurred within the six weeks preceding, affecting a new bridge, a car of structural material, and a steam shovel; the damage in each case was large. Last July a bridge over the Wheeling & Lake Erie Ry. tracks at East 71st St. was dynamited, but the damage was small.

GRADE CROSSINGS numbering 727 in all have been eliminated on the Pennsylvania R. R. system during the past six years. Of these crossings, 568 were on the lines east of Pittsburg and Erie, and 159 on the lines west. On the eastern main lines the grade crossings have been reduced by nearly one-half. More exactly, the number of grade crossings on the lines of heaviest traffic between New York and Washington and Philadelphia and Pittsburg on Jan. 1, 1902, was 904. By Jan. 1, 1908, all but 426 of these had been eliminated, and those remaining are on little used highways and scattered over 571 miles of road. This is a most creditable record and one for which the Pennsylvania Railroad Company well deserves the highest public commendation.

THE BELMONT TUNNEL under the East River at New York City, connecting Manhattan with Long Island City, has been offered to the city by the Interborough-Metropolitan Co., who own the tunnel through the New York & Long Island R. R. About $8,000,000 was asked at first, but a new offer makes the price a little over $7,000,000, provided the company obtains the privilege of operating the tunnel under specified conditions of fares and division of receipts. The Public Service Commission has up to the present declined to deal with the company in the matter, on the ground that the franchise for the enterprise is dead.

A VERY LONG MINE DRAINAGE TUNNEL is being constructed near Pachuca, about 50 miles northeast of Mexico City, Mexico. The tunnel, called the Nepton, is to be about 6 miles long, and passes several hundred feet below the bottom of the deepest mine of the region; its greatest depth below the surface will be about 3,000 ft. The mines of four districts will be drained by the tunnel: Pachuca, Atotonilco el Chico, Real del Monte and Azoyatla. The City of Mexico "Herald" states that the tunnel was begun about 15 years ago, and so far about 5,000 ft. in length has been excavated. Mr. G. Mancera, of Mexico City, who is pushing the enterprise, estimates that it will be completed in four years more.

A COMBINED REFUSE DESTRUCTOR AND ELECtric light and power station was opened early in February, 1908, at Greenock, Scotland. The destructor plant includes six cells, with a combustion chamber and three water-tube boilers. The cells are in pairs, each of which, with its corresponding boiler, can be worked independently. This gives flexibility in shutting down for repairs or cleaning. The efficiency of the cells for heat-raising purposes is increased by alternate firing of the cells of each pair, and also by the common combustion chamber. This aids in keeping up uniform high temperature, ensures thorough combustion of all the noxious gases from the refuse. The furnace grates slope from back to front, have an area of 25 sq. ft. each, a capacity of a cart-load at a single charge, and are equipped with grate-bars perforated with numerous small holes through which a high-pressure air blast is supplied by means of electrically-driven fans. The air inlets to the fans are so placed and arranged as to aid in ventilating and in keeping down the dust in the building. On arriving at the destructor the refuse wagons are tipped through hoppers into boxes placed in a pit. An electrically-operated overhead crane lifts the boxes from the pit to a storage platform. The boxes, of which there are 80, are provided with covers. After the boxes are filled they are not emptied until the furnaces are to be charged, when the boxes are again lifted with the overhead crane and deposited on a cradle placed above the charging holes in the tops of the furnaces. The weight of the box causes the cradle on which it rests to descend and by means of levers and balance-weights to slide a water-sealed door to one side, whereupon cradle and box descend into the furnace top, after which hinged lids at the bottom of the refuse box open outward, thus discharging the refuse onto and over the grate. The charging box is then removed by the crane, and the feed-hole is automatically closed by the water-sealed door. It is stated that the whole charging operation is done in less than a minute, while the feed-hole is opened even a shorter time, thus reducing to a few seconds the inrush of cold air to the furnace. The clinker from the destructors is drawn from doors below at the front of the cells, being pulled out into buckets running on an overhead trolley. The boiler gases pass through a Green's economizer before going to the chimney. Besides the destructor boilers, Babcock & Wilcox double-drum coal-fired boilers are provided. The electric generating plant includes two Belliss-Westinghouse direct-coupled sets of 750-KW. normal output when supplied with steam at 200 lbs. pressure. Triple-expansion engines of 1,140 HP. each are provided. Mr. J. A. Robertson, M. Inst. E. E., is Borough Engineer of Greenock. The foregoing notes are based on an article published in the London "Surveyor" for Feb. 14, 1908.

PERSONALS.

Mr. William Gell has been appointed Master Mechanic, in charge of motive power, cars and shops, on the Grand Trunk Pacific Ry., with headquarters at Winnipeg, Man.

Mr. W. E. Mathews, formerly Chief Engineer of the Ellsworth Coal Co., at Ellsworth, Pa., has allied himself with the Tennessee Coal, Iron & R. R. Co., with headquarters at Birmingham, Ala.

Mr. N. L. Kennedy, for the past two years assistant engineer with the New York, Westchester & Boston Ry., has accepted the position of Manager of the Vacuum & Compressed Air Cleaning Co. at New Rochelle, N. Y.

Mr. A. W. Robinson, M. Am. Soc. C. E., has been commissioned to examine into and report upon the possibilities of improving by dredging the navigation of the River Niger and has sailed for Africa to begin the investigation.

Mr. G. F. Moore has been appointed Inspector of General Accounts for the Interstate Commerce Commission, with headquarters at Washington, D. C. Until recently Mr. Moore has been General Manager of the St. Joseph Valley Ry. at La Grange, Ind.

Mr. Thomas Millen, of the New York City Ry. Co., was the guest of honor at a dinner in New York City on Feb. 29, tendered to him on occasion of his retirement, after 42 years' continuous service, from the office of general master mechanic of the road.

Mr. Edmund M. Blake and Mr. Henry A. Symonds have entered into a partnership for the transaction of a general engineering practice, specializing in sanitary, hydraulic, municipal and gas engineering. Their office will be at No. 8 Beacon St., Boston, Mass.

Mr. John Merwarth, an erecting engineer in the employ of the Ingersoll-Rand Co., is reported to have been killed in an avalanche which, on March 1, destroyed some buildings at the entrance to the Loetschberg Tunnel in Switzerland. As we go to press, the home office of the company has not been able to verify the report.

Mr. Rhinelander Waldo has been appointed Superintendent of the police force which the New York City Board of Water Supply has organized to patrol the Catskill drainage area during the construction of the new water system for the city. Capt. Douglas I. MacKay, late a captain in the U. S. Army, was appointed second in command.

Mr. Lester G. French has been appointed editor of the Proceedings of the American Society of Mechanical Engineers. Mr. French is a graduate of the Massachusetts Institute of Technology and has had a large experience both in engineering practice and editorial work. For four years after graduating he was in shop and drafting room work, mainly with the Builders' Iron Foundry shops of Providence, R. I., and for nine years he was editor-in-chief of "Machinery." More recently he has been engaged in publishing technical books at his father's publishing house in Brattleboro, Vt. He is the author of elementary text books on algebra and applied mechanics and a treatise on steam turbines.

Obituary.

Albert C. Killam, Chairman of the Railway Commission of Canada, died at his home in Ottawa, on March 1, aged 59 years.

Tom Cobb King, M. Am. Inst. Min. Eng., a well-known metallurgist, died in East Orange, N. J., on Feb. 27, at the age of 43 years.

James Oliver, the celebrated plow inventor and manufacturer, died at his home in South Bend, Ind., on March 1, in the 84th year of his age.

William A. Washburne, the New York City sal[illegible]gent of the Cambria Steel Co., died at his country [illegible]e in Salisbury, Conn., on Feb. 26. Mr. Washburne ha[illegible] been connected with the Cambria Co. for about 14 yea[illegible]. Before that time he was with the Pennsylvania Steel[illegible]

Thomas Carson Barr, a leading street railway [illegible] of New Jersey, died at his home in Orange, N. J., [illegible] Feb. 26, aged 50 years. Mr. Barr was born in Phila[illegible]lphia, and received there his education. Up to 1887 [illegible] was engaged in the practice of law in his nati[illegible]city, but in that year he became interested in the man[illegible]ent of street railways and accepted the presidency of [illegible]eral Philadelphia lines. Later he moved to Newark, N. [illegible] has incorporated and operated most of the lines now [illegible]ed by the Public Service Corporation, of which con[illegible] he was a director at the time of his death.

Henry S. Eveline, a contractor well known thro[illegible]out New York State and New England, died at his h[illegible]e in Waterford, N. Y., on Feb. 25, at the age of 61 [illegible]ars. Mr. Eveline emigrated to this country from his [illegible]ative place, Edinburgh, in 1863, and since that time had been engaged in a general contracting business. Amo[illegible] the large works for which he was responsible are the [illegible]swego harbor, the sewer systems of Waterford, Amsterdam, Lansingburg, Little Falls, Oneonta, in the State of New York, and Pittsfield, Melrose, South Framingham and Westfield, in Massachusetts. Lately he had been engaged in the construction of various portions of the new water supply system of New York City. Mr. Eveline is survived by a large family of sons and daughters.

Russell Harding, one of the prominent railway executives of the country, died in New York City, March 3, at the age of 52 years. Mr. Harding entered railway construction in 1870, with his father, who was then contractor on the Portland & Ogdensburg Ry. From 1873 to 1898 he was connected with the engineering departments of a number of western railways, the last few years of that time being General Superintendent of the entire system of the Great Northern Ry. In 1898 he entered the administrative offices of the St. Louis & Southwestern Ry. as Vice-President, and from that time until 1905 he held high executive offices in the Missouri Pacific system, the Pere Marquette R. R. and the Erie R. R. At the time of his death he was associated as railway expert with H. B. Hollins & Co., bankers.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 17-19, 1908. Annual convention at Chicago, Ill.
Secy., L. C. Fritch, 1562 Monadnock Block, Chicago.

AMERICAN RAILWAY ASSOCIATION.
April 22, 1908. Semi-annual session at New York City.
Secy., W. F. Allen, 24 Park Place, New York.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 1-2, 1908. Annual meeting at Albany, N. Y. Secy., Joseph W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN WATER-WORKS ASSOCIATION.
May 11-16, 1908. Annual meeting at Washington, D. C.
Secy., John M. Diven, 14 George St., Charleston, S. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 23-26, 1908. Annual convention at Denver, Colo.
Secy., C. W. Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 23-26, 1908. Annual convention at Detroit, Mich.
Secy., C. W. Rice, 29 West 39th St., New York City.

MONTANA SOCIETY OF ENGINEERS.—The officers for the coming year elected at the annual meeting in January are as follows: President, Archer E. Wheeler; Treasurer, Samuel Barker, Jr., and Secretary, Clinton H. Moore, Butte, Mont.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The regular monthly meeting will be held on Friday, March 13, 1908, at 8 p. m. in the Engineering Societies Bldg., 29 W. 39th St., New York City. Messrs. L. B. Stillwell and H. C. Putnam will present a paper on "Electric Haulage of Canal Boats."

NEW ENGLAND WATER-WORKS ASSOCIATION.—The regular March meeting of the association will be held on March 11, at the Hotel Brunswick, Boston. The two papers of the evening will be "The Typhoid Fever Epidemic at Watertown, N. Y., in 1904," by Dr. George A. Soper, and "Troy Water-Works Extension," by Mr. E. L. Grimes, Chief Engineer, Bureau of Water Supply, Troy, N. Y.

THE OHIO ASSOCIATION OF CONTRACTORS.—The contractors of Ohio recently met at Columbus and organized the above association, the main purposes of which are to secure more uniform specifications in municipal contracts throughout the state and to standardize the various forms in connection with such contracts. The headquarters of the society are in Columbus and the officers are as follows: President, Col. N. B. Abbott; Vice-President, Mr. F. H. Kirschner; Secy. and Treas., Mr. George B. McGrath, Cleveland, Ohio.